This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

NYPL RESEARCH LIBRARIES
3 3433 08162744 4

THE

WORKS

OF

FRANCIS BACON,

BARON VERULAM, VISCOUNT ST. ALBAN, AND LORD HIGH CHANCELLOR OF ENGLAND.

VOLUME THE FIFTH.

CONTAINING

NOVUM ORGANUM SCIENTIARUM.

VOL. II.

LONDON:

PRINTED FOR M. JONES, PATERNOSTER-ROW.

1815.

PUBLIC LIBRARY
108210A
ASTOR, LENOX AND TILDEN FOUNDATIONS

NOVUM ORGANUM.

PART II.—SECTION II.

THE DOCTRINE OF INSTANCES; OR, THE METHOD OF EXPEDITING THE INTERPRETATION OF NATURE, AND THE INVESTIGATION OF FORMS, BY PREROGATIVE INSTANCES*.

APHORISM XXI.

HAVING thus laid down the tables, that afford the first view of a subject†, and given an

* The doctrine of instances is delivered with great diligence, sagacity, and exactness, in the present section. The design is to shew what are the principal, most material, and essential particulars in every enquiry; or what instances are chiefly to be sought after and regarded, in order to discover the real natures of things, with the greatest certainty and expedition. It is a doctrine of the first importance in the discovery of forms, and for want thereof the philosophical enquiries we generally meet with are but light skirmishes, instead of close grapplings with nature; or, without a metaphor, they have no strong and direct tendency to the discovery of forms, but appear vague, indetermined, and rather amusing than useful.

† That is, in the way of example, and not in the way of rigid and just enquiry, which requires much more industry

example of the method of rejection or exclusion, and a specimen of the fruits, or first dawn of doctrine to be derived from them, we proceed to the other helps of the understanding, in the business of interpreting nature, or forming a true and perfect induction. And, in proposing these helps, we shall, wherever tables are required, proceed upon the foregoing subject of heat*; but where fewer examples are sufficient, we will occasionally launch into subjects of all kinds, without confounding our enquiry of heat, on the one hand, or confining our doctrine to too scanty bounds, on the other†.

We therefore propose to treat, 1. of prerogative instances; 2. of the helps of induction; 3. of the rectification of induction; 4. of the method of varying enquiries, according to the nature of the subject; 5. of prerogative natures for enquiry, or what subjects are to be enquired into first, what second; 6. of the limits of enquiry, or an inventory of all the natures in the

---

and exactness, after the manner of the Author's enquiry into the subjects of Life and Death, Winds, Condensation, and Rarifaction; though these also are but a kind of larger examples, and not finished enquiries.

* The tables, for that purpose, being laid down in the preceding section.

† And, in this view, the following Aphorisms will exhibit a little map of the roads for improving all kinds of knowledge.

universe; 7. of reducing enquiries to practice, or making them subservient to human uses; 8. of the preliminaries to enquiry; 9. and lastly, of the ascending and descending scale of Axioms*.

22. Among the prerogative instances for interpreting nature, in the first place come the solitary kind†; that is, 1. those which exhibit the nature enquired after, in such subjects as have nothing common with others, besides that very nature; or, 2. those that exhibit the nature en-

---

* Of these nine general heads, under which the remaining parts of the Novum Organum were to have been comprised, no more than the first is prosecuted by the Author. Nor was any thing afterwards published towards executing the rest, though it appears that the whole design was laid from the first, and that, at times, the other parts were gone on with, after the present piece was published. The want of these additional Sections may, perhaps, be in some measure supplied by a close attention to the present Doctrine of Instances. But, in order to render the whole more generally intelligible and useful, it were greatly to be wished that some tolerably qualified person would give an essay upon it, in as familiar a manner as the subject will allow. See Dr. Hook's Method of Improving Natural Philosophy.

† Let it be remembered that, with regard to the names of the several kinds of instances hereafter mentioned, the Author had a right to impose them, as the subject was entirely new and untouched. And, doubtless, certain definitions and names are required, where things are to be carefully distinguished.

quired after, in such subjects as are every way similar to others, excepting in that very nature. For it is manifest, that such instances as these will shorten the enquiry, and promote and hasten the exclusion *; so that a few of them may do the service of many.

For example, 1. if the enquiry be about the nature of colour, solitary instances are prisms, and crystal gems, or glasses, which represent colours, not only in themselves, but also externally upon a wall, &c. Understand the same of dews, &c. For these have nothing in common with the fixed colours of flowers, coloured gems, coloured glass, metals, various woods, &c. besides the colour itself. Whence it may be easily inferred, that colour is nothing more than an alteration in the rays of light, occasioned, in the first case, by different degrees of incidence †; and, in the second, by the different texture, or structure of the body, and so reflected to the eye. But these instances are solitary, or single, in point of likeness ‡.

---

* See above, *Table* IV. *Aph.* 18

† Viz. In the prism, glasses, dew, &c. Which kind of instance led the Archbishop of Spalato, Dr. Hook, Mr. Boyle, Sir Isaac Newton, &c. to very considerable discoveries in the subject of colours.

‡ Viz. Dissimilar in all respects besides that of colour, in which the solitariness of the instance consists.

(2.) Again, in the same enquiry, the distinct veins of black and white in marble, and the variegation of colours in flowers of the same species, are solitary instances, for the black and white parts of marble, or the spots of white and purple in carnations, agree almost in every respect, except in colour. Whence it is easily collected, that colour does not greatly depend upon the intrinsic nature of the coloured body, but is owing to a somewhat gross, or bare mechanical texture of the parts*. Thus these instances are solitary, in point of difference. And we call both the kinds by one and the same name.

23. In the second place come travelling instances, or those wherein the nature enquired after, travels, or advances to generation, when it was not before in being; or, on the contrary, travels, or tends to destruction, when it was in being before. And, therefore, in either corrolative, such instances are always duplicate; or rather one instance, in motion, or passage, is continued to the opposite period†. And instances of this kind not only accelerate and confirm the business of exclusion, but also drive the affirmation, or form itself, into a narrow compass.

* See Mr. Boyle of colours.

† That is, either there is both a generation and destruction, or else one and the same process begins with generation, and ends with destruction.

For the form of the thing must necessarily be somewhat introduced, or abolished, by this transmigration. And though all exclusion promotes and forwards the affirmation, yet this is more directly done in the same subject, than in different ones; for it plainly appears, from all we have said before, that the form discovering itself in one thing, leads to its discovery in all the rest. But the more simple this passage is, the nobler the instance should be esteemed.

Again, these travelling instances are of great use in practice, because, as they exhibit the form joined with an efficient, or privation*, they clearly design, or mark out the practical operation in some cases; whence any easy passage is also afforded to the neighbouring discoveries. There is, however, some danger in these instances, that requires a particular caution; for they may be apt to restrain the form too much to the efficient, and to infect, or at least to tinge the understanding with a false notion of the form, through an apparent mixture of the efficient; whereas the efficient is never more than the vehicle of the form†. But this inconvenience is easily remedied by making a just exclusion‡.

---

* See above, *Part* II. *Sect.* I. *Aph.* 1, 4, &c.

† See *Part* II. *Sect.* I. *Aph.* 2, &c.

‡ See *Table* IV. *Aph.* 18.

To give an example of a travelling instance; suppose the nature enquired after were whiteness, an instance advancing to generation* is glass, whole, and in powder; and again, simple water, and water beat into froth; for whole glass, and simple water, are transparent bodies, not white; but powdered glass, and the froth of water, are white, not transparent. It comes therefore to be enquired, what has happened to the glass, or water, in this transmigration†; for, it is manifest, that the form of whiteness travels, or is conveyed over by pounding the glass, and agitating the water; but nothing is here found added, besides a bare comminution of the parts of the glass, and the water, together with the interposition of the air. And it is no small acquisition in discovering the form of whiteness, that two bodies, of themselves more or less transparent, viz. air and water, or air and glass, being mixed together, in subtile or small parts, should exhibit whiteness, by differently reflecting the rays of light‡.

We must also give an example of the danger, and caution, above-mentioned; for it may here readily occur to the understanding, depraved by

---

* Viz. The generation of whiteness.

† Viz. From transparency to whiteness.

‡ See Mr. Boyle's History of Colours, Dr. Hook's Lectures of Light, and Sir Isaac Newton's Optics, *passim*.

these kinds of efficients*, that air is always necessary to the form of whiteness, or that whiteness is generated only by transparent bodies, which two positions are absolutely false, and rejected by numerous exclusions†. It will rather appear, without the interposition of the air, &c. that the bodies perfectly uniform, or similar, in their optical parts, prove transparent: that those which have the simple texture, or arrangement of their parts disturbed, are white; that a dissimilarity in the regular texture of bodies, affords all colours, except black; and that a dissimilarity in a compound, absolutely irregular, and confused texture, constitutes blackness‡. And, for an instance advancing to destruction in the same nature of whiteness, we have it in froth subsided, or snow dissolved; for water deposites its whiteness, and puts on transparency, upon becoming entire, without any intermixture of air.

---

* Such as the pounding of glass, the agitating of water, &c. upon which the transparency ensues.

† According to the procedure of *Table* IV. *Aph.* 18. thus ceruse is made of lead, an opake pulpy mass makes white paper, &c. white minerals are found in the earth, white enamels are made in the fire, &c.

‡ Perhaps these intimations carry the enquiry into the causes of colours, on the side of the coloured body, farther than has been generally followed. See Mr. Boyle of Colours, and Sir Isaac Newton's Optics.

We must by no means omit, that under travelling instances should be comprehended, not only those which travel to absolute generation and privation, but such likewise as travel to a greater or less degree of the nature sought, since these also tend to the discovery of the form, as plainly appears both from the definition of a form, above laid down *, and the table of comparison †. And therefore the instance of paper, which is white when dry, but proves less white when wet, and comes nearer to the state of transparency, upon the exclusion of the air, and the reception of the water, is of the same use as the instances above-mentioned ‡.

24. (11.) Among the prerogative instances come in the third place the glaring kind, mentioned in our first dawn of doctrine from the form of heat §; which we also call by the name of shining, released, or predominating instances. And these are such as shew the nature searched after naked and standing alone, and this in an eminent manner, or in the highest degree of its power, as being disenthralled and freed from all impediments, or at least by the strength of its

---

* See above, *Aph.* 4. † See above, *Aph.* 13.

‡ Viz. The whiteness and transparency of glass, water, &c. this latter being a kind of intermediate instance, betwixt the former.

§ See above, *Aph.* 20.

own virtue over-ruling, conquering, and subduing them. For as every body may receive many united and concrete forms of natures, it happens that one may repell, depress, break and bind down another, whence all particular forms are obscured. But there are certain subjects, wherein the nature sought after, appears more in its vigour than in others; either through the absence of impediments, or the predominancy of its own virtue. And instances of this kind are what principally shew the form. But in these also caution must be used, and the alertness of the understanding be repressed, for whatever boasts the form, and obtrudes it, so as that it seems to meet the understanding, should be held suspect*; and recourse be had to a careful and severe exclusion †.

For example, if the nature enquired after be heat; then the weather-glass is a glaring instance of the expansive motion, which is, as we said above, a principal part of the form of heat‡. For flame, though it manifestly shews

* As being very apt to deceive; for men have reason to be assured, that the forms of things are not easy to find. And let it be duly weighed and considered, how many certain instances there are of a true and perfect discovery of forms.

† See above, Tab. IV. *Aph.* 98.

‡ See *Aph.* 12. (37.) 20. *ad finem.* See Tab. I. II. III. IV. and V.

an expansion, yet by reason of its momentary extinction, it does not exhibit the progress thereof. Again, boiling water, because of the easy transition of the water into vapour and air, does not so well shew the expansion of the water in its own body. Again, ignited iron, and the like bodies, are so far from shewing the progress, that, on the contrary, the expansion itself is not visible to the sense, by reason of the re-action and breaking of the spirit in the compact and gross part*; but the weather-glass clearly and evidently shews a true progressive, and durable expansion of the air by heat†.

For a second example; let the nature enquired after be gravity, and then quicksilver will prove a glaring instance, as having a far greater specific gravity than any thing else, except gold, which, however, is not much heavier; but quicksilver is a better instance for disclosing the form of gravity than gold, because gold being a solid and consistent body, its superior gravity may seem owing to its solidity; whereas quicksilver is fluid, and full of spirit, and yet proves much heavier than diamond, or any other of those bodies that are esteemed the most solid. Whence it appears that the form of gra-

* All the five preceding tables are to be consulted on this occasion.

† See above, Tab. II. III. (37.)

vity or weight resides simply in the quantity of matter and not in solidity, firmness or hardness of texture.

25. In the fourth place come those we call clandestine instances, or instances of twilight, which are in a manner opposite to glaring instances, as shewing the nature enquired after in its weakest virtue and imperfect state, or rudiments, striving or, as its were, first attempting to manifest itself, whilst it remains covered and subdued, or kept under by a contrary nature. And there instances are of extraordinary service in the discovery of forms; because, as the glaring instances easily lead to differences, so the clandestine instances easily lead to kinds, that is, to those common natures of which the natures enquired into are no other than limitations*.

For example; let the nature enquired into be consistence or solidity, the contrary of which is liquidity or fluidity, then clandestine instances are such as exhibit some faint and low degree of consistency in a fluid; suppose a bubble of water which is a kind of consistent and determinate pellicule, made of the body of the water. In like manner icicles, if there be water to follow them, lengthen themselves out in a very slender thread, to prevent a discontinuity of the water;

* See above, Part II. *Aph.* 4. Whence it will evidently appear of what great use these instances are.

but if there be not a sufficient quantity to follow, the water then falls in round drops, which is the figure that best supports it against discontinuation; and at the very instant when the thread of water ends, and the falling in drops begins, the water recoils upwards to avoid being discontinued. So in metals, which are fluid upon fusion, though a little tenacious, some of the mettled mass frequently springs up in drops, and sticks in that form to the sides of the crucible. There is a like instance in the looking-glasses, commonly made of spittle by children, in a loop of rush or whalebone, where we find a consistent pellicule of water. But this is observed to much better advantage in that other diversion of children, when they take strong soapy water, and blow in it with a pipe, so as to raise the water into a tower or castle of bubbles, whilst by the interposition of the air, the soapy water becomes consistent to that degree as to be thrown a considerable distance without breaking. This also appears to advantage in froth and snow, which put on such a consistency, that they may be almost cut with a knife, though they are but bodies formed of air and water, both of them fluid. These several instances seem clearly to intimate that fluidity and consistency are no more than vulgar notions relative to the human sense, and that all bodies

have a real appetite to avoid discontinuation, though in homogeneous bodies, such as fluids are, it is but weak and feeble, whilst in those compounded of heterogeneous matters, it proves more strong and powerful, because the application of what is heterogeneous binds bodies up, but the entrance of what is homogeneous relaxes and dissolves them *.

As a farther example; if the nature sought were attraction, or the appetite of approach in bodies, a most remarkable glaring instance, as to the discovery of the form, is the loadstone. The contrary of an attractive nature is an unattractive nature, though in a similar substance; as in iron, which does not attract iron; nor does lead attract lead, nor wood attract wood, nor water attract water. But the loadstone armed with iron, or rather the iron of an armed loadstone, is a clandestine instance; for here it happens, that an armed loadstone does not, at a certain distance, attract iron stronger than an unarmed loadstone; but if the iron be moved so near as to touch the iron of the armed loadstone, then the armed loadstone will support a much greater weight of iron, than the naked and unarmed loadstone, by reason of the

* Consider the instances derivable from chemistry, and the doctrine of menstruums.

similitude of substance betwixt iron and iron, which operation was altogether clandestine and secret, or concealed in the iron before the loadstone was applied. Whence it is manifest, that the form of attraction is a thing that is vivid and strong in the loadstone, but weak and latent in iron.

After the same manner, it is observed, that headless arrows of wood, being fired out of a gun, will penetrate farther into wood, or the sides of a ship, than the same arrow headed or pointed with iron, by reason of the similitude of substance betwixt wood and wood *, though this before lay concealed in the wood.

Again; though air does not manifestly attract air, nor water manifestly attract water, in a state of entireness, yet one bubble approaching another makes it easier dissolve, than if the other bubble were away, by reason of the appetite of conjunction between water and water, and between air and air.

And this kind of clandestine instances, which, as we before observed, have a noble use, are most remarkable in the small and subtile parts of bodies, because the greater masses of things follow the more general and universal forms †.

---

* Is the fact certain? See the *Sylva Sylvarum*.

† We have here a remarkable opening into the doctrine of attraction. See Sir Isaac Newton's Principia and Optics, *passim*.

26. In the fifth place, come constituent or collective instances; that is, such as constitute one species of a nature enquired after, in the way of a lesser form. For, as genuine forms, which are always convertible with the natures sought*, lie deep, and are not easily found; the design itself and the weakness of the understanding require that partial forms, which are collective of certain packets of instances (though by no means of all) into some common notion, should not be neglected, but carefully observed; for whatever collects and unites natures, though it be but imperfectly, paves the way to the discovery of forms. And therefore those instances which are useful to this purpose, have a considerable power and a prerogative nature.

But great caution must here be employed lest, the understanding, after having found many of these particular or partial forms, and hence made arrangements or divisions of the nature sought after, should wholly rest in them, and not apply itself to the legitimate discovery of the great form, but presuppose nature to be manifold and divided, as it were, in the root, and therefore disdain and reject all farther uniting of her, as a matter of needless subtility, and tending to mere abstract speculation.

For example, let the nature sought be

---

* See Part II. *Aph.* 4.

memory, or the means of exciting and helping the memory; the constituent instances will here be, first, order, or distribution, and places for artificial memory. Order, or distribution, manifestly assists the memory; and places for artificial memory, may either be places in a proper sense, as a door, a window, a corner, &c. or familiar and known persons; or any other things at pleasure; provided they be placed in a certain order; as animals, plants, words, letters, characters, historical personages, &c. though some of these are more, and some less fit for the purpose. But such kind of places greatly help the memory, and raise it far above its natural powers. Again; verse is easier learnt and remembered than prose.

And this collection, or packet, of the three abovementioned instances, viz. order, artificial place, and verse, constitute one species of help for the memory: and this species of help may be justly called the prevention of endless search. For when a person endeavours to recollect, or call a thing to mind; if he has no previous notion or perception of what he is in quest of, he casts about, and tries every track, as it were without end: but if he has any previous notion, this infinity of search is presently cut short; and the memory is brought to hunt nearer home. But in the three instances abovementioned, there

is a clear and certain previous notion contained. For in the first, there is required somewhat agreeable to order; in the second, an image is required, that has some agreement, or relation, to those fixed places; in the third, words that will stand in a verse: so that infinity is thus cut off or prevented; and the search limited and restrained.

Other instances will give this second species; that whatever brings an intellectual thing to strike the sense, (which is the method principally used in artificial memory)* helps the remembrance.

Other instances will give this third species; that those things which make an impression by means of a strong affection or passion, as by causing fear, surprize, blushing, delight, &c. assist the memory.

Other intances will give this fourth species; that those things sink the deepest, and dwell the longest in the memory, which are chiefly impressed upon a clear mind, that remains unprejudiced, either before or after the impression; as the things we learn in childhood, or think of just before going to sleep; as likewise all the first times that things are taken notice of.

Other instances will give this fifth species; that

* See the Art of Memory, in the *de Augment. Scientiar.* l. XV.

a multitude of circumstances, or, as it were, handles, or holds to be taken, help the memory: as the making of many breaks in writing, or printing; reading or repeating aloud, &c.

Lastly; other instances will give this sixth species of help; that those things which are expected, and raise the attention, stick better, than such as pass slightly over the mind: whence, if a man should read a writing twenty times over, he would not remember it so well, as if he should read it but ten times, with trying between whiles to repeat it; and consulting the copy where his memory failed.

Hence there are, as it were, six lesser forms of helps for the memory; viz. (1.) the cutting off infinity; (2.) reducing intellectual to sensible things; (3.) impression by a strong passion; (4.) impression upon a mind free and disengaged; (5.) variety of handles, or occasions; and, (6.) expectation conceived.

In like manner, let the nature sought be taste, or tasting; and the following instances are constituent: viz. (1.) those who naturally want their smell, do not perceive or distinguish by the taste, such meats as are musty or tainted; or again, such as are mixed with garlic, roses, and the like.

(2.) Those who have their nostrils obstructed, by the accidental falling down of a rheum, do not distinguish, or perceive things that are putrefied, musty, or sprinkled with rose-water.

(3.) If those who are troubled with this kind of rheum, hold any fetid or perfumed thing in their mouth, and at the same time strongly blow their nose, they immediately perceive the stench or perfume.

These instances will afford, or constitute, this species, or rather part of the form of taste; viz. that the sense of tasting is, in some measure, no more than an internal smell, passing and descending from the upper cavities of the nostrils, to the mouth and palate.

(4.) On the contrary; saltness, sweetness, acrimony, acidity, roughness, bitterness, &c. are all perceived, as well by such persons as want their smell, or have it obstructed, as by any others. Which shews that the sense of taste is a certain composition of an internal smell, and a kind of exquisite touch:* but this is no place to prosecute the subject.

Again, for example, let the nature sought be the communication of quality without commixture of substance. The instance of light will here afford, or constitute one species of communication; and heat, and the loadstone another: for the communication of light is, in a manner, momentary, and ceases immediately upon removing the original illuminating body; but heat

* See the *Sylva Sylvarum*, p. 155, 180, &c.

and the magnetic virtue, when communicated, or rather excited, in any body, lodge and remain therein for a considerable time after the first cause is taken away.

Lastly; these constituent instances have a very high prerogative; as being eminently serviceable in the forming of definitions, especially the particular kind; and again, in the making of divisions, or distributions of natures; with regard to which, Plato said well, That he is to be held as a God, who knows perfectly how to define and divide.*

27. The sixth place may be assigned to those instances which we call parallel, conformable, or proportional instances, and sometimes physical parallels and similitudes; that is, such as shew a similitude, correspondence, and relation betwixt things, not in the lesser forms, like constituent instances†, but entirely in the concrete; and are therefore, as it were, instances of the first and lowest degree, for the uniting of na-

---

* This use will appear evident, by recurring to the beginning of the present Aphorism. And without frequently going back, and comparing one part of these Aphorisms with another, it cannot be expected that their doctrine and use should be fully comprehended.

† See *Aph.* 26

ture*. Nor do they constitute any Axiom immediately from the beginning; but only point out, indicate, or present certain relations of bodies. And although these instances are of no great use in the disclosing of forms, yet they very advantageously lay open the structure of the parts of the universe, or make a kind of anatomy in the members thereof; and therefore sometimes lead up to sublime and noble Axioms, especially such as belong to the configuration of the world, rather than to simple natures and forms†.

For example, parallel, or conformable instances, are such as these; viz. a speculum and the eye, the structure of the ear, and of the cavernous places that yield an echo, &c. from which conformity, besides the observation of the similitude or correspondence (which is useful in

---

* Viz. For discovering the similarity, sameness, or unity of nature, in dissimilar subjects. See above, *Part* II. *Aph* 3.

† This, and the like general descriptions of instances, will be usually intricate and abstruse of themselves, till the subsequent exemplifications are read, which render the whole plain and intelligible. Whence, after reading the examples, it may be proper to go over the general description again, in order the better to take the sense; and observe the correspondence.

many respects) it is easy to form and collect this Axiom, that the organs of the senses, and the bodies that procure reflections to the senses, are of a like nature.

And again, the understanding being thus admonished, easily rises to a still higher and more noble Axiom; viz. that there is no difference between the consents, or sympathies of bodies endowed with sense, and those of inanimate bodies without sense, only that in the former an animal spirit is added to the body so disposed, but is wanting in the latter, whence as many conformities as there are among inanimate bodies, so many senses there might be in animals, provided there were organs, or perforations in the animal body, for the animal spirit to act upon the parts rightly disposed, as upon a proper instrument.

And conversely, as many senses as there are in animals, so many motions there may be in bodies inanimate, where the animal spirit is wanting; though there must, of necessity, be many more motions in inanimate bodies, than there are senses in animate bodies, because of the small number of the organs of sense.

And of this we have a manifest example in pains; for, as there are numerous kinds of pains in animals, and, as it were, different characteristics thereof, there being one pain of burning,

another of freezing, another of pricking, another of squeezing, another of stretching, &c. it is certain that all these, with regard to the motion, exist in bodies inanimate, as they do in animate bodies; for example, in wood, or stone, when burnt, froze, pricked, cut, bent, bruised, &c. though there be no sense attending them in these inanimate bodies, for want of the animal spirit*.

Again, the roots and branches of plants, though this may seem strange, are conformable instances; for every vegetable swells, and thrusts out its parts towards the circumference, as well upwards as downwards, and the difference betwixt the roots and the branches is no more than this, that the root is contained in the earth, but the branch exposed to the air and sun.

For if a young thriving branch of a tree be bent down into any parcel of earth, though it does not reach to the ground, it will soon become a root; and again, if earth be laid on the top of a plant, and be so pressed down by a stone, or other hard substance, that the plant cannot grow upwards, it will shoot out branches downwards, into the air†.

---

* See the *Sylva Sylvarum*, under the article Spirits, &c.

† See the experiments upon Vegetation, in the Philosophical Transactions, French Memoirs, and the Author's *Sylva Sylvarum*.

The gums of trees, and most gems of the rock, are also conformable instances, both of them being no other than exudations, and percolations of juices*. For gums are but the transuded juices of trees, and gems the transuded juices of stones; whence the clearness and transparency of them both are procured, by means of a curious and exquisite percolation. And hence it is, that the hairs and furs of animals are not of such beautiful and vivid colours as many feathers of birds; viz. because the juices are not so subtily strained through the direct skins of beasts, as through the substance of the quill in birds.

The scrotum also in male animals, and the matrix in the female, are conformable instances, so that the noble structure which distinguishes the sexes in land animals, seems to be nothing more than a difference as to external and internal; because, by a greater force in heat suppose, the genital parts in the male sex are thrust outwards, whilst the heat is too feeble in females, to effect such an extrusion; whence those parts in them come to be contained within.

Among conformable instances also come the fins of fish, the feet of quadrupeds, and the feet and wings of fowl, to which Aristotle adds the

* See the article Percolation, in the *Sylva Sylvarum*.

four wreaths of serpents*; so that in the structure of the universe, the motion of living creatures seems generally performed by quadruple limbs, or flexures.

Again, the teeth in terrestrial animals, and the beaks in birds, are conformable instances, which shew, that in all perfect animals, a certain hard substance flows to the head†.

It seems also no absurd similitude, or conformity, that man should resemble an inverted plant, the root of the nerves and animal faculties residing in the head, and the seminal parts being seated below, if we do not take in the extremities of the legs and arms; but in a plant, the root, which answers to the head in a man, is regularly placed below, and the seeds above‡.

But this precept cannot be too frequently inculcated, that the procedure and method of man-

---

* Are there but four wreaths made in the progressive motions of snakes, vipers, &c.? Consider also the motion of caterpillars, worms, &c.

† See the *Sylva Sylvarum*, under the articles Bones and Teeth.

‡ Animals likewise appear to resemble inverted plants in another respect, viz. in having their roots within, whilst plants have them without; for the lacteal veins in animals nearly correspond with the fibres of the roots in plants, so that animals seem nourished from within themselves, as plants are from without.

kind in their enquiries and endeavours to collect a natural history, must be entirely altered from the method at present in use: for men's curiosity and diligence have been hitherto principally employed in observing the variety of things, and explaining the precise differences of animals, vegetables and fossils, the greatest part of which variety and differences are rather the sport of nature, than matters of any considerable and solid use to the sciences. Such things, indeed, serve for delight, and sometimes contribute to practice, but afford little or no true information, or thorough insight into nature; human industry, therefore, must be bent upon enquiring into, and observing the similitudes and analogies of things, as well in their wholes as in their parts; for these are what unite nature*, and begin to build up the sciences.

But here a severe and rigid caution must be used, that those instances only be received for conformable and proportional, which (as we all along require†) denote real physical likenesses and resemblances; that is, such as are true, substantial, and actually lodged and seated in nature, not such as are accidental and showy,

* See above, *Part* II. *Sect.* I. *Aph.* 3.

† See *Part* II. *Aph.* 1, 4, 5, 20, &c. Se also hereafter, *Aph.* 33. *ad finem.*

much less such as are superstitious or vain, like those which the writers of natural magic, (a vain set of men, that scarce deserve to be mentioned in the serious subject we are now upon) every where boast of, in describing, and sometimes, with great levity and vanity, feigning empty similitudes and sympathies.

To proceed, conformable instances are not to be neglected in the configuration of the world itself, with regard to its larger parts. Thus Africa, and Peru, with the continent up to the streights of Magellen, have similar isthmuses and similar promontories, which does not happen without some cause.

So again, both the old world and the new are wide and extended towards the north, but narrow and pointed towards the south.

But among the noblest instances of conformity, come the intense cold in that called the middle region of the air, and the violent fires often found to break out from subterraneal places; for these two things are extremes and limitations, the one limiting the nature of cold towards the arch of the heavens, and the other limiting the nature of heat towards the bowels of the earth, by antiperistasis, or the rejection of a contrary nature.

Lastly, a conformity of instances deserves to be observed in the Axioms of the sciences. So

the figure in rhetoric, called inexpectation, when a matter comes in unexpectedly, is conformable to that figure in music which is called sinking of the cadence*. So again, the mathematical postulate, that things equal to the same third are equal among themselves, is conformable with the structure of a syllogism, in logic, which unites things agreeing in a middle term. To conclude, a certain sagacity in searching out and discovering physical conformities and similitudes, is a very useful thing on many occasions†.

28. In the seventh place come those we term singular, irregular, or hetoroclite instances, borrowing the expression from the grammarians, that is, such as shew bodies, in the whole or concrete, which seem to be out of course, or as if they were broken in nature, so as not to agree with other things of the same kind. For, conformable instances are like something else, but heteroclite, or singular instances are only like themselves.

The use of these singular instances is the same as of clandestine instances; viz. for raising and uniting nature, so as to discover kinds, or common natures, that are afterwards to be limited

* When the music drops, as it were, or sinks on the sudden.

† See the *De Augment. Scientiar.* p. 70. See also the *Sylva Sylvarum, passim.* particularly under the article Sound.

by real differences*. Nor should the enquiry be dropt, or broke off, till the properties and qualities found in such things as may be esteemed miracles in nature, are reduced, and comprehended under some form, or certain law, so that all irregularity or singularity may be discovered to depend upon some common form, and the miracle only rest in the exact differences, degree, and extraordinary concurrence, and not in the species itself. But the contemplations of men at present proceed no farther than to suppose such things as these to be secrets, great works of nature, and as it were causeless, and to make them exceptions to general rules.

As examples of singular instances, we have the sun and moon among the stars, the loadstone among stones, quicksilver among metals, the elephant among quadrupeds, the sense of venereal pleasure among the kinds of touch, and the scent of the blood-hound among the kinds of smell.

So with the grammarians, the letter S is held singular, for the easiness of its composition with consonants, sometimes with double, and sometimes with triple ones, which is a property of no other letter.

A large collection of such instances should be made, because they whet and quicken the en-

* How far this contributes to the investigation of forms may appear from *Aph.* 4, *Sect.* I. *Part* II.

quiry, and also rectify and cure the understanding, depraved by custom, and things of common occurrence*.

29. In the eighth place come deviating instances; that is, the errors of nature, and things monstrous and uncommon, where nature turns aside from her ordinary course. For the errors of nature differ from singular instances, in this, that singular instances are miracles in species, but errors of nature are miracles in individuals: though these deviating instances have nearly the same use with the former; as tending to rectify the understanding, depraved by the things to which it is most accustomed, and to disclose the most common forms. For here also the enquiry is not to cease, till the cause of the deviation be discovered; though this cause does not properly rise to any form; but only to the latent process† that leads towards it: for as he who knows the ways of nature, will the easier observe her deviations; so he who knows her deviations will more exactly describe her ways.

---

* Let it be all along observed, and carefully remembered, that this whole doctrine of instances lays down precepts for conducting enquiries, both general and particular, with a direct view to the investigation of forms, or the full interpretation of nature. And in the light of this intimation, the Author's larger enquiries are also to be considered.

† See *Part* II. *Sect.* I. *Aph.* 1, 4, 5, &c.

They differ in this also from singular instances, that they conduce much more to practice, than those: for it would be very difficult to generate new species; but 'tis easier to vary the known species; and thence to produce many extraordinary and unknown things; there being a ready passage from the miracles of nature, to the miracles of art. For if nature shall once be discovered in her variation, and the reason of it become manifest, 'twill be easy to lead her thither again by art, where she erred by accident; and that not only in one case, but in others: for errors on one side, shew and open the way to errors and deviations on all sides.

And here examples are not necessary; because they are so numerous and common. But a collection, or particular natural history should be made of all prodigious and monstrous births and productions of nature; and of all things new, extraordinary, and uncommon in the universe: but this is to be done with the strictest and most judicious choice; so that it may be safely relied on. And here those things are principally to be held suspect, which in any sort relate to religion; as the prodigies of Livy: and those no less, which are found in the writers of natural magic, alchemy, or other writers of the like kind, who are the professed admirers, or as it were adorers of fable and fiction. But all the

particulars for this purpose are to be derived from grave, judicious, and faithful history, and just relation.

30. In the ninth place come frontier instances; which we sometimes also call participles.* These are such as exhibit those species of bodies which seem composed of two species, or to be rudiments betwixt one species and another; but these instances may be justly reckoned among the singular or hetoroclite kind, † as being rare, or extraordinary in the universe; yet for their dignity they ought to be separately placed and treated. For they excellently indicate the composition and structure of things; and suggest the causes of the number of the ordinary species in the universe; and lead the understanding from that which is, to that which may be.

Examples of these are, (1.) moss, which is something betwixt putrefaction, and a plant; (2.) certain comets, which are of a nature betwixt stars and fiery meteors; (3.) flying-fishes, which are a species betwixt birds and fish; (4.) batts, which are betwixt birds and quadrupeds; (5.) the beast so like ourselves, the ape; ‡ (6.)

* From their participation of two different natures; as a participle, in grammar, participates of a noun and a verb.

† See above, *Aph.* 28.

‡ *Simia quam similis, turpissima bestia, nobis.*

the biformed births of animals; (7.) the mixtures of different species, &c.*

31. In the tenth place come instances of power; or, as we sometimes call them, trophies or ensigns of power, inventions, or the works of mens hands; that is, the most noble and perfect works, and as it were the masterpiece in every art. For since the design is to bend nature to things, and bring her to serve the turn of man;† 'tis absolutely proper that the works already in mens possession should be enumerated and set down, (as so many provinces already subdued and cultivated) especially such works as are best understood, and brought nearest to perfection: because these afford a short and easy passage to farther discoveries. For if any one, after an attentive consideration of the works already extant in this kind, would determine to use his best and strongest endeavours, he might doubtless either carry them somewhat farther, or convert them to some other obvious purpose; or apply

* *Viz.* Mules, mongrels, dogs by the mixture of a dog and a fox; and the like in other beasts, birds, and fish, where the instances can be found.

† Let a clear and strong conception be had of the end in view; which is no less than to acquire such a command and mastery over nature, as that men may use her like a ready instrument, or agent, in effecting the greatest works; such as lengthening life, ruling the weather, and the like; which to vulgar philosophers appear impossibilities.

and transfer them to more noble uses than were known before.*

Nor is this all; but as by extraordinary and uncommon, or miraculous works of nature, the understanding is rouzed, excited, and elevated to the discovery of the forms capable of producing them;† so the like is done by the wonderful and extraordinary works (or miracles) of art; but in a much greater degree: because the manner of effecting, producing, and working such miracles of art, is generally plain; whereas miracles of nature are commonly more obscure and dark. But here the greatest caution is required, that such miracles of art may not depress the understanding, and fix it, as it were, to the earth.

For there is danger lest, in these works of art, which appear like so many ultimate perfections, and utmost stretches of human industry, the understanding should be captivated, chained down,

---

* This directs us to a short and facile method of improving the known arts, and inventing new ones. See the section upon Learned Experience in the *de Augmentis Scientiarum*.

† For every thing producible, is produced by its form. See *Part* II. *Aph.* 4. and the first section throughout. This point being absolutely fundamental, and of the very utmost importance, cannot be too often inculcated, or too well understood: for in this, all the power both of men and nature centers

or, as it were, enchanted with them: so as not to converse with other things; but imagine that nothing of the same kind can possibly be effected in any other way; and that no farther improvement can be made, except by operating in the same way, with greater diligence, exactness, and a better apparatus.

On the contrary, this is to be held certain, that the ways and means of effecting the things and works hitherto discovered and described, are generally scanty and defective; and that all greater power and ability depends, and is regularly deducible from the fountain of forms, not one whereof is hitherto discovered.*

And, therefore, as we formerly observed, though a man should ever so thoroughly have studied the nature of the warlike engines, and battering rams of the ancients, or even have spent his whole life in the enquiry; yet he would never have fallen upon the invention of ordnance, and gun-powder; no more than he who should have employed his observations and thoughts upon the woollen and linen manufac-

* *Vis.* Not according to the precise and infallible method of the author, laid down and exemplified in the first section of this second part of his *Novum Organum*; and farther continued and improved in the present section; which, however, leaves the business imperfect; the completion of the whole being reserved for a third part of this general work. See above, *Aph.* 21.

tures, would have thence discovered the manufacture of silk. *

And hence all the more noble inventions will, if duly considered, be found owing not to slender discoveries, applications, and enlargements of arts; but entirely to chance, or accident; whose slow and lingering motion, with which it creeps through ages, nothing can anticipate, prevent, or shadow out before-hand, but the discovery of forms. †

The things of this kind are so numerous, as to need no particular instances. The direct business is, to visit and thoroughly inspect all the mechanic arts, and all the liberal ones too, with regard to works; and thence to make a collection, or particular history, of the capital discoveries, masterpieces, and most perfect works in each; together with the ways of producing the effect, or the manner of every operation. ‡

But we do not confine the diligence that

---

* See *Part* I. *Aph.* 109, 110.

† Let sufficient attention be given to this paragraph; for much depends upon it.

‡ This was the chief view and design of the Royal Academy of Sciences at Paris; viz. the describing the chief mechanical arts and trades of France, with the engines, instruments, tools, processes, and ways of working made use of by the best masters.

should be used in this collection, to things which are only judged masterpieces and secrets in any art, so as to raise the admiration: for admiration is the child of unfrequency; as whatever happens seldom, though in its kind but vulgar, yet produces wonder.

On the contrary, those things which ought to be admired, by reason of the differences of their species, compared with other species, are slightly passed over, if they are familiar and obvious: whereas the singularities of art are not less to be observed than the singularities of nature, mentioned above:* and as among the singularities of nature, we have placed the sun, and moon, the loadstone, &c. which, though very common things, are almost singular in their natures; the same is to be done in the singularities of art.

For example, paper, though a very common thing, is a singular instance of art. For if well observed, artificial matters are either merely wove with direct and transverse threads, as silk, cloth, linen, &c. or made of concreted juices, as brick, clay, glass, enamel, porcelane, and the like, which if well united shine, but if less united, prove hard, but bear no polish. And all these latter substances, made of concreted juices, are brittle, and do not hold tenaciously together.

* *Aph.* 28.

On the contrary, paper is a tenacious substance, that may be cut, or torn; so that it resembles, and in a manner rivals the skin, or membrane of some animal; the leaves of some plant; or the like production of nature: for 'tis neither brittle, as glass; nor thready, as cloth; for though it has its fibres, yet it has no distinct threads; but exactly resembles the texture of natural matters: insomuch that the like can hardly be found again among artificial things; but it remains perfectly singular. And in artificial things, those, doubtless, are to be preferred which imitate and resemble nature the nearest; or which, on the other hand, powerfully govern, invert, or change her.*

Again; among instances of power, or the inventions and manual works of men, matters of dexterity, delusion, and diversion, are not to be rejected wholly: for some of these, though of small use, and only ludicrous, may yet be rich in information.

Lastly; neither are superstitious, and those commonly called magical matters, to be quite excluded: for although things of this kind lie strangely buried, and deep involved in falshood and fable; yet some regard should be had to discover whether no natural operation is concealed

---

*See the *Sylva Sylvarum*, passim.

in the heap: for example, in fascination; the power of imagination; the sympathy or consent of things at a distance; the communication of impressions, from spirit to spirit, as well as from body to body; and the like.*

32. It appears from what is above delivered, that five of the instances already mentioned; viz. (1.) the conformable; (2.) the singular; (3.) the deviating; (4.) the frontier instances; and, (5.) the instances of power, ought to be reserved, as the rest before explained, and many of the following ought to be, till any particular nature is enquired into; but a collection of them is immediately to be made from the beginning; as a certain particular history; in order to the digesting of the things which enter the understanding, and correct the bad habit of the mind itself; for the mind must needs be tinged, infected, and at length perverted and distorted, by the daily and accustomed inroads and incursions made upon it. †

*See the Articles *Imagination*, and *Sympathy*, in the *Sylva Sylvarum*.

†The meaning is, that by constantly conversing with such things only as are common, familiar, and obvious, the mind acquires a strong bent, or habit; whereby it judges that all things are conformable to these: and hence we frequently impose gross sophistry upon ourselves for truth; and argue, and act, in a strangely perverse and ignorant manner: whereas, before we can reason, judge, or philosophize truly,

These instances, therefore, are to be employed as a certain preparative, to rectify and cleanse the understanding: * for whatever draws the understanding from the things whereto it is accustomed, at the same time lays it smooth and even, for receiving the dry and pure light of just ideas and notions. These instances also prepare and open the way to practice; as we shall shew hereafter. †

33. In the eleventh place come friendly, or accompanying and hostile instances, which we call instances of fixed propositions. These are such instances as exhibit a body, or concrete, wherein the nature enquired after constantly attends, as an inseparable companion; or, on the contrary, wherein the nature sought perpetually absents and disappears, as a foe or enemy. And of this kind of instances, fixed, determinate and general propositions are formed, either negative or affirmative; wherein the subject will be a certain body in the concrete, and the predicate, will be the nature sought. ‡ But particular proposi-

---

the mind must be acquainted and familiarized with things of agreeing, disagreeing, participating, singular, and extraordinary natures; as well as with those of the common, the obvious, and ordinary kind. See the Doctrine of Idols, *Part* I. *Aph.* 38—61. * *Viz.* From its idols.

† See below, Aph. 50, of the present section.

‡ So, in the enquiry of heat, flame is the subject, in the concrete; and heat the predicate, or nature sought.

tions are by no means fixed, where the nature sought is fluctuating and moveable in any concrete; whether it be coming on, or acquired; or again, going off or deposited: therefore particular propositions have no great prerogative; excepting only in the case of transmigration, of which we spoke above.* Yet even these particular propositions are of great use, when confronted, and compared with those that are universal; as we shall shew in its proper place.† But we do not require, even in these universal propositions, a rigorous or absolute affirmation or negation; they being sufficient for the purpose, though there should be some singular or rare exception to them.

The use of accompanying, or friendly instances, is to bring the affirmation of the form to a narrow compass; for, as in the travelling instances,‡ the affirmative of the form is contracted, so that the form of the thing must be found to be somewhat introduced, or destroyed, by the act of transmigration; after the same manner, in accompanying instances, the affirmative of the form is so pent up or confined, that it must necessarily be somewhat that may attend

* See above, Aph. 23.

† Which seems to be in the ascending and descending scale of axioms, which is wanting. See above, *Aph.* 21.

‡ See above, *Aph.* 23.

and enter such a concretion of body, or else fly from and shun it; whence he who well understands the constitution or structure of this body, will not be far from disclosing the form of the nature sought.

For example, let the nature sought be heat, and an accompanying instance is flame; for in water, air, stone, metal, and numerous other bodies, heat is moveable, and may come and go, but all flame is hot; so that heat perpetually attends in the concretion or whole of flame. But there is no hostile instance * of heat to be found; for as to the internal parts of the earth, the sense has no cognizance thereof, but of all the bodies known to men, there is no concrete unsusceptible of heat †.

Again, let the nature sought be consistence, and air is a hostile instance ‡; for metal may flow, and be consistent; so may glass; water likewise may be consistent, when it is froze; but it is impossible that air should ever be consistent, or put off its fluidity.

But there remain two admonitions with regard to these instances of fixed propositions, useful to the business in hand: the first is, that

---

* Viz. The converse of an accompanying instance.

† See the *Tables* for investigating the form of heat.

‡ Because consistence always flies from air; or, in other words, always remains fluid.

if an affirmative or negative be universally and plainly wanting, this should be carefully noted as a non-entity, as we did in the subject of heat *, where a negative, as to all the bodies within our knowledge, is universally wanting †.

In like manner, if the nature sought be eternity, or incorruptibility, we have universally no affirmative upon this earth ‡; for neither can eternity or incorruptibility be attributed to, or predicated of any substance below the celestial bodies, or above the internal parts of our globe.

The other admonition is, that to the universal propositions, as well affirmative as negative, with regard to any concretes, those concretes also be subjoined §, which seems to approach nearest to that which is the non-entity; as for example, in the subject of heat, the softest or mildest flames, or such as burn the least ‖; and again, in the subject of incorruptibility, gold, which comes the nearest to an incorruptible body; for all these

---

* See *Tables* II. and III.

† All the known bodies being, without exception, susceptible of heat. See *Table* III. *Aph.* 20.

‡ That is, nothing here below is excluded from corruptibility and change.

§ See below, *Aph.* 34.

‖ Suppose the flame of spirit of wine, the *Ignis Fatuus*, or that harmless lambent flame, if real, said to have played about the heads of certain children.

things indicate the limits of nature, or shew the distance betwixt existence and non-existence, and serve to confine or circumscribe forms, so as to keep them from sliding or wandering out of the limits and conditions of matter*.

34. In the twelfth place come the subjunctive instances, mentioned in the preceding aphorism, which we otherwise call instances of extremity, or termination; for these instances are not only useful, as being subjoined to fixed propositions, but also by themselves, in their own particular; as excellently shewing the true divisions or separation of nature; the measures of things; and how far nature may act and suffer; and again, they shew the transition of nature from one thing to another.

Of this kind are gold, in weight; iron, in hardness; the whale, in bulk of animal body; the hound, in point of scent; the explosion of gunpowder, in sudden expansion; and the like. Those things also which are last in the lowest degree, should be no less regarded than those that are first in the highest; as spirit of wine in

* It deserves to be observed, how extremely careful and solicitous the author is to keep his forms from being any way notional or abstract things, which one might, at the first mentioning, be apt to suppose them; especially as men's ears have been accustomed to Aristotelian forms.

weight or levity; silk, in hardness or softness; the minute worms of the skin, in animal bulk *, &c.

35. In the thirteenth place come instances of alliance, confederacy, or union; that is, such as mix and unite natures, supposed to be heterogeneous, and noted and marked out for such by the divisions commonly received. For these instances of alliance shew, that the operations and effects attributed as peculiar to certain heterogeneous natures agree also to others, so as to prove that the heterogeneity which was founded in opinion is not true or essential, and nothing more than the modification of a common nature. Whence these instances are of excellent use to rouze and elevate the understanding from differences to genuses or kinds, and to take off the masks, and discover the counterfeit resemblances of things that occur and present themselves dressed, as it were, in concrete substances.

For example, let the nature sought be heat; in this case it seems a settled and authorized division, that there are three degrees of heat, viz. (1.) that of the heavenly bodies; (2.) that

* These are correlative to the former; so that the two kinds limit nature both ways, or as well in the descending as in the ascending scale.

of animals; and (3.) that of fire: and that these heats (especially one of them compared with the other two) are in essence and species, or in their specific natures, perfectly different and heterogeneous, as the celestial and animal heats generate and cherish, but the heat of culinary fire corrupts and destroys. Here, therefore, we have an instance of alliance in that common experiment, when a grown branch of a vine is brought withinside of a house, or into a room where a continual fire is kept, so as to ripen the grapes a month sooner than the grapes of the same vine are ripened without doors; whence it appears, that fruit, even while it hangs upon the tree may be ripened by culinary fire, though, such ripening might seem to be a peculiar work of the sun.

And upon such an information as this, the understanding easily rouses, throws off the notion of essential heterogeneity, and enquires into those real differences to be found betwixt the heat of the sun and the heat of culinary fire, which cause their operation to be so dissimilar, though they partake of a common nature.

These differences will be found to be four; viz. (1.) that the heat of the sun, with respect to the heat of fire, is much more mild and gentle in degree; (2.) that it is of a much moister quality, especially as derived to us through the

air; (3.) and principally, that it is very unequal, approaching one while increased in strength, and afterwards receding decreased, which is a thing of capital use to the generation of bodies, for it was justly observed by Aristotle, that a chief cause of the generations and corruptions upon the surface of the earth, is the oblique motion of the sun through the zodiac; whence the heat of the sun, partly by the alternate changes of day and night, and partly by the succession of summer and winter, becomes wonderfully unequal. And yet this philosopher immediately after, corrupts and spoils his own just position, for rashly presuming to judge of nature, as his manner is, he very magisterially assigns the cause of generation to the approach of the sun, and the cause of corruption to its retiring; whereas both the access and recess of the sun give occasion to generation, as well as to the corruption of things; not respectively, but as it were indifferently; for inequality of heat administers to their generation and corruption; but equality of heat to their conservation only. *.

There is a fourth difference, of very great moment, between the heat of the sun and of fire;

* See the *Sylva Sylvarum*, under the articles Preservation and Putrefaction.

viz. that the sun insinuates its operation for great lengths of time; whereas the operations of the fire, through the impatience of mankind, are hurried to a conclusion, in short intervals. But if any one were intent upon tempering the heat of fire, and reducing it to a moderate and gentle degree, which is easily practicable several ways, and would sometimes sprinkle and intermix a little moisture; and particularly if he would imitate the heat of the sun in point of inequality, and wait with patience somewhat longer than men usually do in chemical processes, he might get quite clear of that false notion of the heterogeneity of heat, and easily imitate, rival, or in some cases exceed the operations of the sun by the means of culinary fire*.

We have a like instance of alliance in butterflies benumbed, and as it were become dead with cold; for these creatures are re-animated, or brought again to life, by means of a small warmth of fire; whence it easily appears, that fire can as well vivify animals, as ripen vegetables. Thus in the famous invention of Fracastorius, the metalline pan, strongly heated and applied near the head of a person in a dangerous fit of the apoplexy, expands the animal spirits,

* Here is a foundation laid for a kind of chemistry that seems to be very little known or practised.

compressed and, as it were, suffocated by the humours and obstructions of the brain, and thus excites them to motion, in the same manner as fire operates upon water or air, and at the same time consequently expands and quickens them.

Sometimes also eggs are hatched by the heat of a fire, which in this respect perfectly resembles animal heat. These instances therefore, with numerous instances of the like kind, render it unquestionable, that the heat of fire may in many cases be modified, so as to resemble and imitate the celestial and animal heats.

Again; let the nature sought be motion and rest. Here it seems a settled division drawn from the depth of philosophy, that natural bodies either revolve, move in a straight line, or continue at rest; because motion is either without end, proceeding to an end, or stationary in the end. Now constant rotation seems proper to the heavenly bodies; station or rest to the terrestrial globe; and the other bodies called heavy and light, being out of their natural places, are carried strait upwards or downwards to the masses or congregations of similar bodies; those that are light, towards the heavens, and those that are heavy towards the earth: and all this appears neat and plausible in discourse.

But we have an instance of alliance in some of the lower comets, which, though they de-

scend below the celestial bodies, yet move irregularly through the various quarters of the heavens, as appears by experience and observation.

Another instance of alliance relating to this subject is the motion of the air, which between the tropics, where the circles of rotation are larger, seems itself to revolve from east to west.

The flux and reflux of the sea might be another instance of alliance, if the sea was observed to revolve, though but slowly and faintly, from east to west; yet so as to be driven back twice a day. Upon these suppositions, therefore, it is manifest, that this motion of rotation does not terminate in the celestial bodies, but is communicated also to the air and ocean*.

Again; that property of ascending upwards, found in light bodies, labours under a defect; and to this purpose an instance of alliance may be taken from a bubble of water, for if air be thrust under water, it hastily ascends to the surface, by the motion of impulse, as Democritus calls it, wherewith the descending water impels and raises the air upwards, and not by the striving or endeavour of the air itself, but

* See the Essay upon the ebbing and flowing of the sea.

when it comes to the surface of the water, the air is kept from ascending farther, by a small resistance it meets with in the water * which will not presently yield to be discontinued or separated, so that the appetite of the air to rise upwards is exceeding weak †.

In like manner, let the nature sought be gravity. It is a received difference, that dense and solid bodies move towards the centre of the earth, but rare and light ones towards the heavens, as if, in each case, it were to their proper places. But as to these places, though the notion of them prevails in the schools, yet it is perfectly idle and childish to imagine that place can have any effect. Whence it is trifling in philosophers to assert, that if the earth was perforated, heavy bodies, let fall in the perforation, would stop at the centre; for, in that case, a kind of nothing, or a mere mathematical point, would have a virtue and efficacy ‡; so as either

* The wates now throwing itself into a thin film, or spherical bubble, to avoid a solution of continuity.

† Or, according to the late discoveries, none at all. See Mr. Boyle's Works, and Sir Isaac Newton's Principia, *passim*.

‡ This is the general case of mathematical demonstrations applied to physics, where mere mental powers or forces are supposed, instead of those that really exist in nature. Hence great caution is required in the reading of mathematical writers upon physical subjects, lest ideal

to affect other bodies, or other bodies to affect it; whereas body is never affected but by body.

This appetite of ascent and descent is either in the structure of the body moved, or in a sympathy or consent with some other body. But if any dense and solid body can be found, which does not move to the centre of the earth, this received difference will be falsified. And if the opinion of Gilbert be admitted, that the magnetic virtue of the earth, whereby it attracts heavy bodies, extends not beyond its own sphere of activity, which always operates to a certain distance, and no farther; and this be verified by any instance, such an instance will be an instance of alliance upon this subject; but at present there is no certain and manifest instance thereof *.

What seems to come nearest to it, is the cataracts or spouts which are met with in sailing through the Atlantic Ocean towards either the East or West Indies; for the quantity and bulk

---

powers should be inadvertently introduced into matter. And let it be well considered and remembered, that what is mathematically just and true, may be physically false and absurd.

* Sir Isaac Newton's doctrine and discoveries upon this head are now generally known. But, perhaps, the physical cause of gravity still remains unassigned; so far, we mean, as it may be.

of water suddenly discharged by these cataracts appears so great, that they seem to be collections of water made before, and to have rested and remained in these places, and afterwards to be thrown down by some violent cause, rather than to fall by the natural motion of gravity. Whence we may conjecture, that a dense and compact body of a large bulk may remain at a great distance from the earth, pendulous, like the globe of the earth itself, without falling, till it be violently precipitated or thrown down*. But with regard hereto we affirm nothing for certain.

Only in this and numerous other cases it may easily appear how deficient we are in natural history, when, instead of verified and assured instances, we are often obliged to bring bare suppositions in the way of examples †.

Again; let the nature sought be the reasoning faculty. A just distinction here seems made betwixt the human reason and the sagacity of brutes; yet there are some instances of actions which brutes perform, whereby they also seem to reason. Thus it is reported of a raven, that in a time of great drought, espying water in the hollow trunk of a tree, where the orifice was too small for her to enter, she continued to

* See the account of spouts in the Philosophical Transactions.

† See above, *Part* II. *Aph.* 14.

drop small stones therein, till the water rose high enough for her to drink. Whence the reason of the raven afterwards became proverbial.

Lastly, let the nature sought be vision. Here it seems to be an extremely just and exact distinction betwixt light and colour, that light is an original visible thing, affording the primary means of sight, and that colour is a secondary visible thing, not to be seen without light, whence it may seem no more than the image or modification of light, and yet there appear to be instances of alliance on both sides. Thus, for example, in large quantities of snow, there seems to be a somewhat original, lucid colour*; and in the flame of sulphur, a light tending to colour†.

36. In the fourteenth place come those we entitle Crucial Instances, deriving the word from the crosses set up where two roads meet, to point and mark out their separation again. We otherwise call them Decisive, and Indicatory Instances; and, in some cases, Oraculous and Commanding Instances.

---

* For snow affords a considerable degree of light, by means whereof men travel by night in the northern regions. See Mr. Boyle's History of Cold, *passim*.

† Viz. Blueness.

They are of this kind, that when in the search of any nature, the understanding comes to an equilibrium, as it were, or stands suspended as to which of two or more natures the cause of the nature enquired after should be attributed, or assigned, by reason of the frequent and common concurrence of several natures, then these Crucial instances shew the true and inviolable association of one of these natures to the nature sought, and the uncertain and separable alliance of the other, whereby the question is decided, the former nature admitted for the cause, and the other rejected.

These instances therefore afford great light, and have a kind of over-ruling authority, so that the course of interpretation will sometimes terminate in them, or be finished by them. Sometimes, indeed, these Crucial Instances occur, or are found, among those already set down, but in general they are new, and expressly and purposely sought and applied, or after due time and endeavours, discovered, not without great diligence and sagacity.

For example, let the nature sought be the tide of the sea, which happens twice in the day, and is six hours in coming in, and six in going out, with a certain difference coinciding with the motion of the moon. Now, the cross-way of this subject lies as follows.

This reciprocal motion must of necessity happen either, 1. from the waters going forward and backward, like water moved in a bason, which, when it rises on one side, forsakes the other; or, 2. from the rising and falling down of the waters, like water that rises in boiling, and again subsides; but to which of these causes the ebbing and flowing of the sea should be assigned, is the doubt. If the former assertion be admitted, when the sea flows on one shore, it must necessarily ebb, about the same time, somewhere on the opposite shore; the enquiry therefore is thus brought to a point.

Now Acosta, and some others, have found, by diligent observations, that on the coast of Florida, and the coasts of Spain and Africa, the sea flows and ebbs at the same times; not contrariwise, that when it flows on the coast of Florida, it ebbs on the coasts of Spain and Africa; and yet, when carefully considered, the rising motion is not proved by this, and the progressive motion disproved; for it is possible that the waters may have a progressive motion, and yet overflow the opposite shores of the same channel at the same time; that is, if the waters be protruded and driven from another quarter, which is the case of rivers ebbing and flowing on both shores at the same hours, though the mo-

tion here be clearly progressive, viz. the motion of the waters entering at the mouths of the rivers from the sea.

It may, therefore, happen, in like manner, that an immense collection of waters, rolling from the Indian Ocean, may be compelled and driven into the channel of the Atlantic, and thus overflow both shores at once. It must, therefore, be enquired, whether there is any other channel through which the waters may at the same times be discharged or taken off, and we find there is the South Sea at hand, a sea not less than the Atlantic, but rather wider, and of larger extent, which may suffice for this purpose.

And thus at length we come to the Crucial Instance in this subject, and it lies thus. If it be once certainly discovered, that when it is flood on the opposite coasts of Florida and Spain, in the Atlantic Ocean, it is also flood on the coast of Peru, and along the coast of China, in the South Sea, then the question is determined by this decisive instance, and the flux and reflux of sea we enquire after, is shewn to happen by a progressive motion, for there is no other sea, or place left, where the return or reflux should be at the same time. And this may most commodiously be known, by enquiring of the inhabitants of Panama and Lima, (where the Atlantic

and Southern oceans are separated by a small isthmus) whether the sea flows on the contrary parts of that isthmus, at the same time, or not.

And this decision, or determination, seems certain, upon a supposition of the stability of the earth; but if the earth revolve, there might thence possibly happen, from the different velocity between the rotatory motion of the earth, and the waters of the sea, a violent protrusion or compulsion of the waters in a heap upwards, so as to make the flux: and a falling of this heap downwards, after it could be kept up no longer, so as to make the reflux. But of this a separate enquiry should be made. Yet upon this supposition, it remains equally certain, that the sea must of necessity ebb in some places at the same time that it flows in others.

In like manner, let the nature sought be the latter of these two motions; viz. the motion of the sea spontaneously rising up, and subsiding again. If it should happen, that upon a careful examination, the progressive motion we speak of must be rejected, then the cross-way of this nature would lie thus, or go off in three different roads. For it must necessarily happen, that this motion, whereby the waters rise in flowing, and again fall back in ebbing, (without any additional waters joining them) must proceed in one of these three ways, viz. 1. either this quantity of

waters must spring, or flow, from the bowels of the earth, and again fall back into its receptacle; or, 2. the quantity of water is not enlarged, but only the same quantity extended, or rarified, so as to possess a greater space, or dimension, and again contracted; or, 3. neither the quantity nor the bulk is enlarged, but the waters, remaining both of the same weight and density, are raised by some attractive virtue, that draws them upwards, and calls them forth by consent, and then permits them to go again.

Therefore, dropping the two other motions, let the enquiry, for example, be reduced to the last, and the question will be, whether any such rising may happen by a consent, or attractive virtue. And here, in the first place, it is manifest, that all the waters, as they lie collected in the cavity, or bason of the sea, cannot be lifted up in one mass together, for want of something to succeed them at the bottom*; and therefore, though they had any such appetite of raising themselves, yet it would be broken and prevented by the connection of things; or, as the common phrase is, by nature's abhorrence, or dread of leaving a vacuum behind. It remains, therefore, that they must rise in one part, and consequently be dimi-

* Nothing, by supposition, could here succeed but atmospherical air.

nished and give way in another; whence again it will follow, that the attractive virtue, as it cannot operate equally upon the whole, must operate strongly upon the middle, so as to raise the waters there; and when they are thus raised, the shores will be successively left, or forsaken by the waters*.

Thus, at length, we come to the Crucial Instance. For if it be found, that in the ebbing of the sea the surface of the water is more arched, and spherical, while the waters rise up in the middle, and leave the sides, that is, the shores, shallow; and if in the flowing, the same surface shall become more flat and equal, viz. whilst the waters return to their former situation, then it may doubtless be admitted that the sea rises by attraction, or otherwise it should be totally rejected. And it were not difficult to try, by the sounding line in streights, whether in the tide of ebb towards the middle of the sea, the sea be not deeper and higher than in the tide of flood. But if this shall prove the case, it must be observed, that, contrary to the common opinion, the waters rise in the ebb, and fall in the flood, so as

* As is now generally allowed to be the case. See Sir Isaac Newton's Theory of the Tides, explained by Dr. Halley in the philosophical Transactions, No. 226.

in the latter only to cover and overflow the shores.

Again, let the nature sought be the spontaneous motion of rotation; and in particular, whether the diurnal motion, whereby the sun and stars rise and set, to the sight, be a true motion of rotation in the heavenly bodies, or only apparent in them, and real in the earth. The following may be a Crucial Instance in this enquiry. If any motion, from east to west, is found in the ocean, though it be ever so languid and feeble, if the same motion be found somewhat quicker in the air, especially between the tropics, where, because of the larger circles, it will be more perceptible, if the same motion be found brisk and strong in the lower comets, if the same motion be found in the planets, so dispensed and proportioned, that the nearer it comes to the earth, the slower it proves, and the farther off the quicker, but quickest of all in the sphere of the fixed stars, then doubtless the diurnal motion should be received for real in the heavens, and the motion of the earth be rejected, because it would then be manifest that the motion from east to west is perfectly cosmical*, and by consent of the universe, which having the greatest

* Viz. As belonging to the whole system of things.

velocity in the greatest heights of the heavens, gradually decreases, and at length terminates, and comes to nothing, in what is immoveable, viz. the earth.

On the other hand, let the nature enquired into be that other motion of rotation, famous among astronomers, and opposite and contrary to the diurnal motion, viz, the motion from west to east, which the astronomers attribute to the planets and sphere of the fixed stars, but Copernicus and his followers assign likewise to the earth; and let it be sought whether there is any such motion in nature, or whether it be only imaginary, and supposed for the readiness and convenience of calculation, and the sake of the beauty and regularity of a system, so as to make the celestial motions performed in perfect circles.

This motion is by no means proved true and real in the higher celestial bodies, neither from hence, that a planet does not, in its diurnal motion, return to the same fixed star again, nor from hence, that the poles of the zodiac differ from the poles of the world, which are the two things whereon this motion is founded. For, the first phænomenon is well solved, by the supposition of antecedence and dereliction, and the second by spiral lines, so that the inequality of the revolution, and the declination to the tro-

pics, may be rather modifications of the same diurnal motion, than contrary motions, or performed about different poles. And if we may here, for once, side with the vulgar, and leave the fictions of astronomers and the schools, (who in many cases, without reason, offer violence to the senses, and rather affect obscurities,) we judge this motion to be to the sense, such as we have above described it, from a model we once had purposely made of iron wire to represent it.

But it may be a crucial instance in this enquiry, if it shall be found from any history worthy of credit, that there was a comet, which did not revolve in a manifest consent (though ever so irregularly) with the visible diurnal motion; but rather to the opposite part of the heavens, for then it will be free to judge that some such motion, contrary to the visible diurnal rotation, may exist in nature. But if nothing of this kind can be found, such a motion should not be embraced, but recourse be had to other crucial instances about it *.

Again; suppose the nature sought was gravity, this will be the cross-road. Heavy and ponderous bodies must either have a natural tendency to the centre of the earth, on account

* See the author's Specimen of animated Astronomy.

of their proper mechanism, or else be attracted by the corporeal mass thereof, as by a collection of bodies of the same nature, and so be carried to it by consent.

If the latter be the cause, it will follow, that the nearer all heavy bodies approach to the earth, the stronger, and with the greater force and velocity they will tend to it; but the farther they are from it, the weaker and the slower, and this to a certain distance; whence, if they were removed so far from the earth, as that the virtue thereof could not act upon them, they would remain pendulous, like the earth itself, without falling *.

And with regard hereto this may be a crucial instance. Take a clock that moves by weights, and another that moves by a steel spring; let them be exactly adjusted, that neither of them may go faster than the other; place the clock that goes with weights upon the top of some very high building; keep the other below; then carefully observe if the clock above move slower than usual, on account of the diminished virtue of its weight. Let the same experiment be made in the deepest mines, to shew whether such a clock will not move faster there, for the

* Compare this with Sir Isaac Newton's Laws of Motion. See his Princip. in init.

contrary reason; and if the virtue of the weights shall be found diminished above, and increased below the surface of the earth, let the attraction of the terrestrial mass be received as the cause of weight or gravity.*.

Again; let the nature sought be the verticity of the magnetic needle; and the cross-way will be this: the touch of the magnet must either of itself necessarily give iron the property of pointing north and south; or else only excite and prepare, or fit the iron for the purpose; and the motion itself (as Gilbert conceives, and laboriously endeavours to prove) be given by the presence of the earth; and, therefore, the particulars, which he has with much sagacity and industry discovered, amount to this; that an iron nail, which has long continued in the direction of north and south, may by that mere continuance receive a verticity, without the touch of the magnet; as if the earth itself, though it operates weakly, by reason of its distance, (for the surface or external crust of the earth has no magnetic virtue, according to him,) should yet, in so great a length of time, supply the defect of the loadstone, excite the iron, and afterwards make it comply when thus excited. And again; that if ignited iron be quenched, point-

* See Sir Isaac Newton's Principia, *passim*.

ing in the direction of north and south, it also receives a verticity without the magnetic touch, as if the parts of the iron, put in motion by the ignition, and afterwards contracting themselves in the very instance of quenching, were more susceptive and sensible of the virtue rising from the earth, than at another time; and thence become animated: but these particulars, though well observed, do not clearly prove his point.

This may be a crucial instance in the present case. Mark the poles of a terella, and place them east and west; then lay an untouched needle thereon, and let it remain for six or seven days. The needle, no doubt, whilst it lies upon the magnet, will quit the poles of the world, and conform to those of the magnet; and therefore, as long as it remains thus, it points east and west. But if the needle shall be found, when removed from the terella, or magnet, and placed upon its pin, immediately to turn north and south, or by degrees to move into that direction, then the earth's presence is to be admitted for the cause; but if it turns as before, east and west, or loses its verticity, then that cause should be accounted doubtful, and farther enquiry be made *.

* See the *Sylva Sylvarum*, under the article Magnetism.

In like manner, let the subject of enquiry be the substance of the moon, to determine whether it be rare, flamy, or aerial, as many of the ancient philosophers conceived; or solid and dense, as Gilbert, with many of the moderns, and some of the ancients, contend. The reasons of the latter opinion depend chiefly upon this, that the moon reflects the rays of the sun, and that light appears to be reflected by none but solid bodies. And, therefore, if there are any, those may be reckoned crucial instances, with regard to this subject, which demonstrate that reflection may be made by a rare body, as flame is, provided it be sufficiently thick.

And, doubtless, one cause of the twilight, among others, is the reflection of the sun's rays from the upper part of the air. We sometimes see the rays of the sun reflected in clear evenings, from the edges of dewy clouds, with a more resplendent brightness than that afforded by the body of the moon; and yet it is not certain that those clouds are collected into a dense body of water. So likewise we see that the dark air behind a window by night reflects the light of a candle, as well as a dense body.

Experiment also should be made of transmitting the sun's rays through a hole, upon a dusky or blue flame, for the free, open, and uncon-

fined rays of the sun, falling upon obscure flames, seem to deaden them, and make them appear rather like white fumes than flames*. And these are instances that occur for the present, to shew the nature and use of the crucial instances with regard to this subject, though, doubtless, better may be found for the purpose. But let it always be observed, that a reflection from flame is not to be expected, unless the flame be of some depth, thickness, or body; for otherwise it inclines to transparency. But this is to be held certain, that light in an uniform substance, is always either received and transmitted or reflected†.

Again; let the nature sought be projectile motion, as the motion of a dart, an arrow, a bullet, &c. through the air. This motion the schools according to their custom, have slightly passed over, esteeming it sufficient to distinguish it by name of violent motion, from that they call natural; and for the first impulse, satisfying themselves with this, that two bodies cannot be in the same place, otherwise a penetration of dimensions would ensue, without at all regarding the continued progress of this motion.

---

* See Sir Isaac Newton's Optics, *passim*; and Dr. Hook's Lectures of Light.

† See Mr. Boyle of Colours, and Sir Isaac Newton's Optics.

The cross-way here lies thus. This motion is either caused by the air propelling and gathering itself behind the projectile, as the water does behind a ship, and the winds behind the chaff which they blow away, &c. or else by the parts of the body not sustaining the impulse, but urging forward to relax themselves, by succession, from the impelling force. Fracastorius, and nearly all those who have made any subtile enquiry into this motion, take the first path; nor can it be questioned, but the air has some share herein, though, doubtless, the other motion is a true one, as appears from numerous experiments.

But, among the rest, this may be a crucial instance to the purpose; that a piece of stubborn iron plate, wire, a quil, or the like, being bent in the middle by the fingers, will, when let go, spontaneously fly back. Now, it is plain, that this motion cannot be attributed to the air, collecting itself behind the body; because the origin of the motion is in the middle of the plate, wire, or quill, and not in the extremities or ends*.

Again; let the nature sought be the rapid and powerful expansion of gunpowder into flame, whereby such vast masses of building, are over-

* See the essay upon Violent and Projectile Motion.

turned, and such great weights thrown to a considerable distance, as we see in the springing of mines, the firing of mortars, &c. The double road here lies thus. This motion is either excited by the mere appetite of the body to dilate itself after it is set on fire, or by a mixed appetite of the crude spirit of the nitre, which, with great rapidity, avoids and flies from fire; and violently bursts out from the midst thereof, as from a prison. The schools and the vulgar opinion here consider only the former appetite; for men have thought they philosophized notably, in asserting flame to be endowed by the form of the element, with a necessary quality of possessing a larger space, than the same body possessed when it had the form of gunpowder, and that this motion must from thence ensue.

But here they observe not, that, though this be true, upon supposition the flame is ready generated, yet the generation of flame may be hindered by a mass of matter able to suppress and suffocate it, so that the thing may not be reduced to the necessity they speak of. Indeed, as to the necessity of the expansion, and the consequent explosion, or discharge of the bullet, or obstructing body, when the flame is generated, they judge rightly; but this necessity is plainly avoided, if the solid body suppress or prevent the flame, before it is generated. And

we see that flame, especially in its first generation, is soft and gentle, requiring a cavity wherein to play and exert itself; whence such a violence cannot be attributed to flame of itself.

Without doubt, the generation of this flatulent flame, or, as it were, fiery wind, arises from a conflict of two bodies, that have very different natures; the one being highly inflammable, which is the nature powerful in sulphur; the other highly impatient of flame, which is the case in the crude spirit of the nitre: whence a wonderful conflict arises; the sulphur immediately catching all the flame it is capable of, and the spirit of nitre bursting forth with all its violence, at the same time dilating itself, as air, water, and all crude bodies do, when affected by heat, and whilst it breaks forth, and flies off every way, it blows up the flame of the sulphur, as it were with internal bellows; the willow-coal, in the composition, serving for little more than to incorporate and commodiously unite the sulphur and salt-petre together*.

But the crucial instances upon this subject might be of two kinds; the one with regard to those bodies which are most inflammable, as

* See the Essay upon the Cause of the Motion of Explosion in guns and gunpowder.

sulphur, camphire, naphtha, &c. with their mixtures; and which, if not otherwise hindered, take flame more easily than gunpowder; from whence it is plain, that the appetite of inflammability does not of itself produce this stupendous effect.

The other kind is, of those bodies which resist and repel flame, as all salts do; for we find, when these are thrown into the fire, a watery spirit breaks out, with a crackling noise, before they take flame, which the more stubborn kind of leaves * do also in a gentler manner; their aqueous part bursting forth before their oily part takes flame. But this appears more eminently in quicksilver, which is not improperly called a fossil, or metallic water; for quicksilver, without taking flame, almost rivals the force of gunpowder, by bare eruption and simple expansion †, and being mixed with gunpowder, is said to increase the strength thereof ‡.

---

* Such, in particular, as ivy, bays, &c.

† That is, supposing the quicksilver close confined and heated, as it might be, to shew the thing, in a gun-barrel, with the touch-hole stopped, and the charge hard rammed down with paper, &c.

‡ Consider of the *Aurum Fulminans*; the common *Pulvis Fulminans*; the ways of making the *Mercurius Fulminans*; and the means of increasing the strength of gunpowder, by salt of tartar, precipitated metals, &c.

Lastly, let the subject of enquiry be the transitory nature of flame, and its momentary extinction; for the flamy nature does not with us appear permanent and at a stay, but to be momentarily generated, and presently after extinguished again. It is manifest, that in the flame here supposed to be continued and durable, the duration is not of the same individual flame, but happens by a succession of new flame regularly generated, without continuing numerically the same, as easily appears from hence, that if the fuel or aliment be taken away, the flame presently goes out.

The two ways in this subject lie thus. The momentaneous nature proceeds either from a remission of the cause that first produced it, as in light, sounds, and those called violent motions; or else from hence, that flame, in its own nature, cannot subsist here below without suffering and being destroyed by the contrary natures around it.

This therefore may be a crucial instance in the case. We see in great conflagrations, that flames will ascend to a considerable height; for the wider the basis of the flame, the higher its vertex rises, and therefore extinction appears to begin about the sides, where the flame is compressed and opposed by the air; but the inner parts of the flame untouched by the air, and

every where surrounded by other flame, remain numerically the same, without being extinguished, till they come to be gradually squeezed by the air diffused about the sides, and therefore all flame is pyramidal, or large in its basis, about the fuel, but sharp at the vertex, the air being its antagonist, and not supplying fuel. But the smoak, which is narrower about the basis, dilates itself in ascending, and becomes like an inverted pyramid, because the air receives smoak, but compresses or squeezes flame. And let no one fondly imagine, that flame is air set on fire, for flame and air appear perfectly heterogeneous*.

We might have a more accurate crucial instance to this purpose, if the things could be manifested by flames of different colours. Take, therefore, a small metalline dish, and fix therein a small wax-taper lighted; set the dish in a wider vessel, and pour spirit of wine round it in a moderate quantity, so as not to touch the upper rim or edge of the dish; fire the spirit of wine, and this will exhibit a bluish flame; but the wax-taper, one that is yellower: and now let it be observed, whether the flame of the taper remains pyramidal, which may easily be distinguished through the blue-coloured flame

* Dr. Hook's Lectures of Light, *passim*.

of the spirit of wine (for flames do not presently mix as aqueous liquors do,) or whether it tends not to a spherical figure, as there is nothing present to destroy or compress it. And if the latter prove to be the case, it may be held certain, that flame remains numerically the same, so long as it is surrounded by other flame, without feeling the hostile effect of the air *.

And so much for crucial instances, upon which we have been the fuller, that men may gradually learn and accustom themselves to judge of nature by instances of the cross, and experiments of light; and not by probable reasonings †.

37. In the fifteenth place, among prerogative instances, come the instances of divorce, which indicate the separation of such natures as frequently meet or come together. These differ from the subjunctive kind, or instances subjoined to accompanying instances ‡; because those indicate the separation of a nature from a con-

---

* This is a subtile experiment, and of great moment.

† Which are endless, and lead to no solid determinations. And by this time, if the reader has been tolerably attentive and diligent, he will have a clear perception of the superior excellence and use of this Doctrine of Perogative Instances, and be enabled, in some tolerable degree, to prosecute Enquiries by their means, in order to the full investigation and discovery of the forms of things.

‡ See above, *Aph.* 33 and 34.

crete wherein it familiarly appears, but these the separations of one nature from another. These also differ from Crucial Instances, as determining nothing, but only admonishing us of the separability of one nature from another.

Their use is to discover false forms, and to dissipate superficial notions and speculations arising from obvious things, so that they add, as it were, ballast to the understanding.

For example, let the subject of enquiry be those four natures which Telesius calls chamber-fellows, as if they came out of the same room, viz. heat, light, rarity, and mobility, or aptness to motion. Now though these natures seem to be nearly related, yet there are many instances of divorce found among them; for, 1. the air is rare, and ready to motion, but not hot or shining; 2. the moon is lucid, without heat; 3. water is hot, without light; 4. the motion of the magnetic needle in the compass, is swift and nimble, yet that needle is a cold, dense, and opake body; and there are many other examples of this kind*.

Again, let the subject of enquiry be the corporeal nature, and natural action; for natural action seems to be no where found, but as it subsists in some body or other, and yet with regard

* By comparing this with *Aph.* 4. of the present part, the use of these Instances, in discovering false Forms sufficiently appear.

hereto, there may perhaps be instances of divorce, as in the magnetic action suppose, where iron is attracted to the loadstone, and heavy bodies to the globe of the earth; to which may likewise be added, some other operations performed at a distance. For this kind of action is both performed in time by successive moments, or not instantaneously, and in place by degrees, and through space; whence, consequently, there is some moment of time, and some distance of place, wherein this virtue, or action, must be in the middle, between the two bodies that cause the motion.

The consideration, therefore, amounts to this, whether the bodies, which are the boundaries of the motion, dispose or alter the intermediate bodies, so as that by succession, and real contact, the virtue may slide from point to point, and in the mean time exist in the intermediate body, or whether there be nothing of this kind, besides the bodies, the virtue, and the space, or distance.

Now, in the case of the rays of light, sounds, heat, and some other things operating at a distance, it is probable, that the intermediate bodies are affected and altered, the rather because a qualified medium is required to convey such operations. But the magnetic, or attractive virtue, passes through all mediums indifferently, for it is not hindered by any one. But if this

virtue or action is independent on the intermediate body, it follows that it is a natural power or action, subsisting for a time in some place without a body, since it neither subsists in the terminating nor intermediate bodies. And hence the magnetic action may be an instance of divorce, in the subject of corporeal and natural action.

To this may be added, by way of corollary, the following considerable discovery, viz. that by philosophizing, even according to sense, a proof may be had of the existence of separated and incorporeal beings and substances; for if natural virtues and actions flowing from a body may subsist without a body for some time in space or place, it is possible that such virtues or actions may proceed originally from an incorporeal substance: for a corporeal nature seems no less required to support and convey, than to excite and generate, a natural action.

38. Now follow five orders of instances, which by one general expression we term instances of light, or instances of primary, and original information, being such as administer to the senses; for as all interpretation of nature begins from sense, and, from the perception of the senses, leads in a strait, continued and guarded path, to the perceptions of the understanding, which are true notions and axioms, it necessarily fol-

follows, that the more copious and exact the representations or informations of the sense shall be, the more easy and successful every thing else will prove*.

The first of these five orders of instances of light, are such as strengthen, enlarge, and rectify the immediate actions of the senses. The second are such as bring down insensible things to sensible. The third are such as indicate the continued processes or series of those things and motions, which remain generally unobserved in their end or period. The fourth substitute somewhat to the sense in those cases that leave it perfectly destitute. And the fifth raise the attention and edge of the sense, and at the same time limit the subtilty of things. To each of these five kinds we shall speak in their order†.

39. In the sixteenth place, we therefore range instances of entrance, or instances of the portal; by which we mean those that assist the immediate actions of the senses. But of all the senses the sight has the chief prerogative in point of information, and, therefore, helps are principally to be sought for the improvement of the

---

* This paragraph being fundamental and leading, requires to be well understood and remembered; the business of raising Axioms depending upon it.

† See below, *Aph.* 39—43.

sight. And these helps may appear of three kinds, viz. (1.) such as enable us to see things that are otherwise invisible; (2.) such as enable us to see things at a greater distance; and, (3.) such as cause to see more exactly and distinctly.

(1.) Of the first kind are the newly invented microscopes, which shew the latent, and otherwise invisible small parts of bodies, and their secret textures and motions, remarkably increased in the magnitude of the object, by means whereof, the exact figure and lineaments of the body of the minutest creatures, such as flies, fleas, mites, &c. as also colours and motions, before invisible, may be seen in a delightful and surprising manner*.

And here, as is usual in new and strange discoveries, a superstitious observation has crept into the minds of men, as if this invention of microscopes did honour to the works of nature, but dishonour to the works of art, by shewing the one much finer than the other†; whereas the

* See Dr. Hook's Micographia, Dr. Power's Experiments, and Leuwenhoeck's Observations.

† Because some microscopical observers, upon viewing the point of a needle, or other the finest works of the hand, and comparing these with the hairs, or downy feathers of animals, &c. find the former to be coarse, rough, and unfinished, in comparison of the latter, and thence fondly extol the excellence of the works of nature, above those of art.

truth only is, that natural textures are much more subtile than artificial ones. For these microscopes are only of use in the case of minute objects, so that if Democritus had seen them, he would perhaps have rejoiced, and imagined a way was now discovered for rendering the atoms visible, which he pronounced to be no object of sight.

But the unsuitableness and insufficiency of these microscopes, except for very minute bodies, (and then only when such minute bodies are not parts of larger) destroys the use of the invention; which, if it could be extended to large bodies, or to small particles of large bodies, in the piece, after the manner of making a piece of fine lawn appear like a net, so as that by this means the latent small particles and inequalities of gems, liquors, urine, blood, wounds, and many other things might be distinguished, great conveniencies would doubtless arise from the discovery*.

Of the second kind are telescopes, which were nobly attempted and discovered by Galilæo; by

* But no considerable improvement of this kind has hitherto appeared, the greatest magnifiers being the smallest globules, or spheres of glass. See Sir Isaac Newton's Optics; Dr. Hook's Lectures of Light, and Micographia; and the Elements of Dioptrics in Wolfius's Elementa Matheseos Universæ, Tom. II. p. 284.

means whereof, as by boats or little ships of intelligence, a nearer commerce may be opened and carried on with the celestial bodies. For by the help of these glasses, 1. the milky way appears to be a knot or cluster of little stars, perfectly separate and distinct, of which the ancients had but a bare suspicion. 2. And again, by their means it should seem, that the planetary regions contain more stars besides the direct planets*, and that the heavens may begin to be spangled with stars at a great distance below the sphere of the fixed stars, though with such only as are invisible, without the help of telescopes. And again, 3. by their assistance we may behold the motion of those small stars, or satellites, about the planet Jupiter; from whence it may be conjectured, that the revolutions of the stars have regard to several centres†. - 4. Again, by their means, the luminous and opaque inequalities are more distinctly perceived and ascertained in the moon, from whence a geographical description might be made thereof‡. 5. And lastly, by means of these glasses, spots in the sun, and other things of that kind, appear to the sight, all which are, doubtless, noble discoveries, so

* Viz. The Satellites of Jupiter, &c.

† As in Sir Isaac Newton's System they are found to have.

‡ As is done by Hevelius, in his Selenographia.

far as they may be safely depended upon for real. But, indeed, I the rather incline to suspect them, because experience seems wholly to rest in these few particulars, without discovering, by the same means, numerous others, equally worthy of search and enquiry*.

(3.) Of the third kind, are those staffs, astrolabes, and the like instruments, for measuring distances, which not only enlarge and improve the sight, but also rectify and direct it†. And as for the instances that assist both this and the other senses, in their immediate and individual actions, without affording any information beyond that assistance, we here omit them, as making nothing to the present purpose. And hence we do not mention the contrivances for correcting any particular defect of the sight, because these afford no farther information.

40. In the seventeenth place, among prerogative instances come those we call summoning or citing instances, borrowing the term from the

---

* See the Author's Essay towards a Philosophical History of the Heavens. And Sir Isaac Newton's Planetary System, in the Third Book of his Principia.

† The instruments of this kind are numerous, and their descriptions frequent in the writings upon Instruments, Levelling, Practical Mathematics, Navigation, &c. See these writers enumerated at the end of the second Tome of Wolfius's Elementa Matheseos Universæ.

bar, where persons are summoned, or cited to appear, who did not appear before; and, accordingly, these instances bring down insensible things to such as are sensible.

Things escape the senses, either, 1. through the distance of the object, as to place; 2. through the interception of interposing bodies; 3. because the object is unfit to make an impression upon the sense; 4. because the object is not sufficient, in quantity, to strike the sense; 5. because the time is not proportionate, so as to actuate the sense; 6. because the percussion of the object is not endured by the sense; 7. and lastly, because an object before detained, and possessed the sense, so as to leave no room for a new motion.

And these several ways chiefly regard vision in the first place, and touch in the second; for these two senses give information at large, and of common objects, but the three others give little information, besides what is immediate, and relates to their corresponding objects.

In the first way there is no reducing the object to sense, except, when things cannot be perceived by reason of the distance, others are used, or substituted for them, which may excite and strike the senses at a great distance, as in giving signals by the lighting up of fires, the ringing of bells, &c.

In the second way, a reduction is made, when such things as lie concealed within, by reason of the interposition of bodies that cannot be commodiously opened, are brought to the senses, by means of those things which are upon the surface, or flow from within; as the state of the human body is known by the pulse, or urine; and the like.

But the reduction in the third and fourth ways regard numerous particulars, and ought on all sides to be collected in enquiries. Thus, for example, it appears that the air, the spirit, and things of that kind, which in their whole substance prove light and subtile, can neither be perceived nor touched, whence in the enquiry after such bodies, we must necessarily use reductions.

Suppose, therefore, the subject of enquiry were the action and motion of the spirit included in tangible bodies; for every tangible body, with us, contains an invisible and untangible spirit, over which the body is drawn like a garment. And hence arise those three powerful springs, and that wonderful process, of the spirit in tangible bodies, For, 1. the spirit being discharged out of a tangible body, the body contracts and dries; 2. whilst detained, it makes the body tender, supple, and soft; and, 3. being neither totally discharged, nor totally held in, it in-

forms, fashions, assimilates, ejects, organizes, &c. And all these are rendered sensible by visible effects *.

For in every tangible, inanimate body, the included spirit first multiplies itself, and, as it were, feeds upon those tangible parts which are most disposed and prepared for that purpose; and thus digests, works, and converts them into spirit, till at last they fly off together.

And this business of making and multiplying the spirit, is brought down to the sense, by the diminution of the weight of the body; for in all drying, part of the quantity goes off, which is not only the spirit that pre-existed in the body, but a part of the body itself, that was before tangible, and is now newly converted into spirit, for the pure spirit has no gravity †.

The emission, or exit, of this spirit is rendered sensible by the rusting of metals, and other corruptions and putrefactions of that kind, which stop before they come to the rudiments of life;

---

* This requires to be well understood, and is explained in what follows; but for farther information, see the *Sylva Sylvarum*, and History of Life and Death.

† In the air at least, as being specifically lighter than air. But whether any thing farther be here meant by spirit having no gravity, will best appear from the Author's History of Life and Death, the History of Condensation and Rarifaction, &c.

for in the more compact bodies, the spirit finds no pores and passages through which to escape; and is therefore obliged to protrude the tangible parts, and drive them before it, so as to make them issue at the same time; whence proceeds rust, and the like*.

But the contraction of the tangible parts, after some of the spirit is discharged, upon which dryness ensues, is made sensible by the increased hardness of the body, but much more by the subsequent cracking, or splitting of the body, and the contracting, wrinkling, and overwrapping of the parts. Thus the parts of wood crack, or split asunder, and are contracted; skins wrinkle, and if the spirit be suddenly forced out by the heat of fire, they shrink so fast as to curl and roll themselves up, &c.

On the other hand, where the spirit is detained, and yet dilated and excited by heat, or some-

* Rust is now usually supposed to be occasioned by the external air, or something contained therein, that preys upon, and in part dissolves the external surface of the metal. Here then is what the Author calls a Cross-Road, that requires a Crucial Instance. Let trial, therefore, be made, whether iron will rust in an exhausted receiver. And, by the way, let not the examples here produced, as illustrations of the doctrine of Prerogative Instances, be supposed any way intended as decisive, their design being rather logical than philosophical, so as to shew the way of prosecuting enquiries, and not themselves to serve as enquiries.

thing analogous thereto, (as happens in the more solid or tenacious bodies) then the body is either softened, as in the case of ignited iron, or flows, as in melted metals, or liquifies, as in dissolved rosin, wax, &c. therefore these contrary operations of heat, hardening some bodies, and liquifying others, are easily reconciled; because in the first case the spirit is driven out, but agitated and detained in the second; the latter being the proper action of heat and spirit, and the former the action of the tangible parts, succeeding upon the emission of the spirit.

But where the spirit is neither quite detained, nor quite discharged, but only attempts and tries to force its prison, and readily meets with such tangible parts as will obey, and yield to its motions, so that wherever the spirit leads they follow it, then it is that an organical body is formed, with its distinct parts or limbs, and that all the vital actions ensue, as well in animals as vegetables.

And these operations are principally brought down to the sense, by diligently observing the first beginnings, rudiments, strugglings, or tendencies towards life, in the little creatures bred from putrefaction, as in the eggs of ants, in worms, flies, frogs after rain, &c. For they are required to vivification, both gentleness of heat, and tenacity of body, that the spirit may neither

break forth too hastily, nor be too much confined, by the stubbornness of the parts, but rather be able to mould and fashion them, like wax.

Again, that noble difference of the spirit, which has regard to so many things, is brought and submitted, as it were, to view, by numerous summoning or reductory instances*. This difference, we mean, is that of the truncate spirit, the spirit simply ramous, and the spirit both ramous and cellulous: the first whereof is the spirit of all inanimate bodies, the second the spirit of vegetables, and the third the spirit of animals†.

In like manner, it appears, that the more subtile textures and structures of things, (though visible and tangible in their entire bodies) are neither seen nor felt; and, therefore, in these also the business of information proceeds by reduction. But the most radical and primary difference of structures is taken from the greater or less quantity of matter contained in the same space or dimension; for the other structures depending upon the dissimilarity of the parts contained in the same body, and their situations, are but secondary, in respect to those.

Thus, let the subject of enquiry be the expansion or contraction of matter in bodies respec-

* See the *Sylva Sylvarum*.

† See the History of Life and Death.

tively, to discover what quantity of matter fills what quantity of space in each. Now, there is nothing truer in nature, than those twin-propositions, that nothing can never make something, and that something can never be reduced to nothing; but the entire quantity, or total sum of matter in the universe, still remains the same, without increase or diminution. It is also as certain, that a greater or less quantity of matter is contained under the same space or dimensions, according to the difference of bodies*. Thus water contains more matter than air; whence to assert, that an equal bulk of water is convertible into an equal bulk of air, is to assert, that something is reducible to nothing; as, on the other hand, to assert, that a certain bulk of air may be turned into an equal bulk of water, is the same as to assert, that something may be made out of nothing. And from this greater or less quantity of matter, those notions of density and rarity, which are variously and promiscuously received, may be corrected, or new ones justly derived.

It must be likewise allowed as certain, that this greater or less quantity of matter we speak

* On this is founded the use of the Hydrostatical Balance. See the Author's History of Condensation and Rarifaction.

of, contained in bodies, may, by comparison, be brought to calculation; and the exact, or nearly exact, proportion determined. Thus, for example, we should not greatly differ from the truth to say, that a given bulk of gold contained about two-and-twenty times as much matter as an equal bulk of spirit of wine; or that a bulk of spirit of wine, equal to the bulk of gold, must possess about two-and-twenty times as much space as the gold *.

But the density of matter, and the proportions thereof, are made sensible by weight, for weight corresponds to quantity of matter, with regard to the tangible parts of bodies; but spirit, and its quantity of matter, is not cognizable by the balance, because it rather diminishes than increases weight. And, with this view, we have made a table, to shew the specific gravities, or weights and bulks, of all the metals, the principal stones, woods, liquors, oils, and many other bodies, as well natural as artificial. And such a table we judge to be of infinite use, as well to procure the light of information, as to serve for a rule in practice, and again to discover many particulars, that would have been absolutely unexpected.

---

* See the Author's Table of the Specific Gravities of Bodies.

It is no small advantage of this table to demonstrate, that all the variety found in the numerous tangible bodies known to us, (which are compact, and neither spongy, hollow, nor in great part filled with air) exceeds not the proportion of twenty-two to one*. So finite a thing is nature, at least that part thereof whose use principally regards ourselves†.

We also thought it worth trying to discover the proportions of untangible, or pneumatic bodies, with respect to such as are tangible, for which purpose we took an ounce vial, chusing it small that the following evaporation might be performed with the less heat. This vial we filled almost to the neck, with such spirit of wine as we observed by the table mentioned above, to be specifically lighter, or to contain less matter under the same dimension, than all other tangible bodies that are close and compact. Then we exactly marked down the weight of the spirit, and the vial together. After this, we took a bladder, containing about a quart, and squeezed all the air out, as near as possible, till the sides of the bladder collapsed,

* Suppose the difference in specific gravity between gold and spirit of wine.

† Viz. The tangible part.

and became contiguous, having first gently oiled it, to render it the closer or tighter, by filling up the pores, if there were any. This bladder we strongly tied with a wax thread about the neck of the vial, putting the mouth of the vial into the neck of the bladder, then setting the vial upon a chafing-dish of warm embers, the vapour of the spirit, dilated by the heat, and thus rendered pneumatical, gradually distended or swelled out the bladder every way, like a sail. Then we immediately removed the glass from the fire, and placed it upon a carpet, to prevent its breaking by the cold, and now we directly made a hole in the upper part of the bladder, lest the vapour, as the heat diminished, should fall back, or condense into liquor, and disturb the calculation. Then taking away the bladder, we weighed the remaining spirit of wine, and thence computed how much was wasted in vapour; and, by comparison, calculating how much space the body possessed in the form of spirit of wine in the vial; and again, how much it possessed when rendered pneumatical in the bladder, it plainly appeared, that the body, so converted and changed, acquired a degree of extension a hundred times greater than it had before.

In like manner, let the nature sought be heat or cold, so weak in degree as to be imperceptible.

These are brought to the sense by means of a weather-glass, such as we have above described*, wherein heat expands, and cold contracts the air. Neither is this expansion and contraction of the air perceptible by sight; but the air, when expanded, depresses water, and when contracted, raises it up; and thus alone it is that the thing becomes visible and sensible, and not otherwise.

In like manner, let the subject of enquiry be the mixture of bodies, to determine what they contain that is aqueous, oleaginous, spirituous, saline, earthy, &c. or, in particular, how much butter is contained in milk, how much curd, how much whey, &c. All these things are reduced and brought down to the senses by artificial and skilful preparations, exhibited in the form of tangible bodies†. But the nature of the spirit in them, though not immediately perceived, is discovered by the various motions and endeavours of tangible bodies, in the act and process of their separation, as also by the acrimony, corrosiveness, different colours, smells and tastes of the same bodies after separation.

And, with regard hereto, men have bestowed great pains upon distillations, and artificial se-

---

* *Aph.* 13.

† As in all those called Chemical Analyses, or Resolutions.

parations, but not with much better success than in the other experiments hitherto practised, as having proceeded altogether by feeling out their way in blind roads, or with more labour than understanding; and, what is worse, without imitating, copying, or rivalling nature, but by their violent heats, and overpowerful operations, destroying all the subtilty of structure, in which the secret virtues and relations of things are principally seated*.

Nor have men, as we elsewhere observed†, hitherto taken notice with regard to this kind of separations, that numerous qualities, in the torturing of bodies, as well by fire as otherwise, proceed from the fire itself, and the matters employed in the separation, which qualities were not before in the composition; whence strange fallacies have arisen. Thus all the vapour which water emits by fire, is not the vapour, or air, before existing in the body of the water, but in great measure produced by the dilatation of the water, through the interposition of the heat of the fire.

---

* Hence there are few genuine separations to be found in the common chemistry, even as practised by the best hands. See the *Sylva Sylvarum*, under the article Gold, &c.

† See above *Part* II. *Aph.* 7. and the *Sylva Sylvarum*.

So likewise, in general, all exquisite trials and examinations of bodies, whether natural or artificial, made to distinguish the genuine from the adulterate, and the better from the worse, should be referred to this head, as these also make what is insensible to appear sensible, and therefore are, with great care, to be collected from all quarters*.

As to the fifth way of concealment from the senses, it is manifest that the action of sense is performed in motion, and motion in time, whence, if the motion of any body be either so slow, or so swift, as not to be proportioned to the moments wherein the act of sensation is performed, the object will not be perceived, as we find in the motion of the hand of a clock, and the motion of a bullet discharged from a gun.

But the motion which is not perceived through its slowness, is easily and commonly reduced to sense, by the result or amount of the motion; but that which is imperceptible through its velocity, is not hitherto well measured, yet the enquiry of nature demands that this should be done in some cases†.

---

* See Mr. Boyle's Medicina Hydrostatica; and the *De Augmentis Scientiarum*.

† Thus the motion of sounds, and even of light, which seems the swiftest motion of all, is now reduced to calculation. See the Author's History of Sounds, in the *Sylva Syl-*

In the sixth case, where the sense is hindered by the too great power of the object, reduction is made either, 1. by removing the object farther from the organ of sense; or, 2. taking off from its force by the interposition of such a medium as may weaken, but not annihilate it; or, 3. by admitting and receiving the reflexion of the object, where the direct force of it is too strong, as by receiving the reflexion of the sun in a bason of water.

The seventh case of concealment from the senses, (viz. that wherein the sense is so full charged with the object, as to leave no room for the admission of a new one) is almost wholly confined to the sense of smelling, and odours, and does not considerably regard the subject in hand. So that thus much may suffice for the business of reducing insensible things to such as are sensible.

Sometimes also reduction is made, not to the sense of man, but to the sense of other creatures, whose sensations, in some particulars, exceed those of men, as the sensation of a hound, in some kinds of smell, and the sensations of a cat, an owl, &c. which see things in the night by the latent light of the air, which is not externally

---

varum; and Sir Isaac Newton's Optics, and Principia, *passim*.

illuminated. For Telesius has justly observed that there is a certain original light in the air itself, though small, faint, and generally unserviceable, with regard to the eyes of men, and many other creatures; because the animals to whose sense this light is proportioned can see by night, which it is not so probable they should do without light, or by an internal light of their own *.

It must here be observed, that we treat only of the failures and insufficiencies of the senses, and the remedies thereof; for the deceptions of the senses should be referred to the particular enquiries of sense and sensibility †, excepting only that grand fallacy of the senses, in making the measure and rule of things correspond to man, and not to the universe, which is an error that cannot be corrected, but by reason and universal philosophy ‡.

41. Among our prerogative instances, we assign the eighteenth place to journeying instances, which we also term instances of the road, and sometimes jointed instances; that is, such as indicate the motions of nature, gradually continued or connected. But the instances of

* See the Author's Table of Enquiry for the History of Light and Splendor.

† See *De Augment. Scientiar*; and the *Sylva Sylvarum*.

‡ See *Part* I. *Aph.* 42, &c.

108210

this kind rather escape the observation than the sense. And, indeed the negligence of men is here surprizing, for they contemplate nature only by fits and starts, or periodically; and then too it is after bodies are complete and finished, and not in their process, or whilst the operation is in hand. But if any man desired to consider and examine the contrivances and industry of a certain artificer, he would not be content to view only the rude materials of the workman, and then immediately the finished work, but covet to be present whilst the artist prosecutes his labour, and exercises his skill. And the like course should be taken in the works of nature.

For example; if any one would enquire into the vegetation of plants, he should have an eye from the first sowing of the seed, and examine it almost every day, by taking or plucking up a seed after it had remained for one, two, or three days in the ground; to observe with diligence, (1.) when, and in what manner, the seed begins to swell, grow plump, and be filled, or become turgid, as it were, with spirit, (2.) Next, how it bursts the skin, and strikes its fibres with some tendency upwards, unless the earth be very stubborn: (3.) How it shoots its fibres, in part, to constitute roots downwards; in part, to form stems upwards; and sometimes creep-

ing sideways, if it there find the earth more open, pervious, and yielding, with many particulars of the same kind *.

And the like should be done as to eggs during their hatching, where the whole process of vivification, and organization might be easily viewed; and what becomes of the yolk, what of the white †, &c. Understand the same of creatures bred from putrefaction; for as to perfect, terrestrial animals, it is somewhat inhumane to enquire into them, by cutting the fœtus out of the uterus, unless when opportunity offers by death, abortions, the fortune of the chace, &c. A watch, therefore, is by all means to be kept upon nature, as she is better discovered by night than by day ‡, for these contemplations and enquiries may be called nocturnal, by reason of the smallness, or durability, or slow-burning of the watch-light here set up.

The same is also to be attempted in inanimate bodies; and this we have endeavoured af-

* See Dr. Grew's Anatomy of Plants, as also that of Malpighi, and several Pieces to the same purpose in the Philosophical Transactions, French Memoirs, &c.

† See Harvey, Highmore, Malpighi, &c. upon this subject.

‡ Viz. Where she is removed from human sight, as she is in these grand Works, the Formation of Vegetables, Animals, and Minerals.

ter by observing the ways wherein liquors open themselves by fire; for water opens one way, wine another, vinegar another, verjuice another; and milk, oil, &c. with a still greater difference; as may easily be perceived by boiling them over a soft fire, in a glass vessel *. But these things are here touched lightly; the place for treating them more exactly and fully being when we come to enquire into the latent process of things †; for it must be all along remembered, that we do not, at present, treat things themselves, but barely produce examples.

42. In the nineteenth place come supplemental instances, or instances of substitution, which we also call instances of refuge; that is, such as afford information where the senses perfectly fail us, so that we have recourse to them when the proper instances cannot be had. This substitution is procured two ways, viz. either by approximation, or by analogy.

For example; there is no medium found, that can possibly exclude the operation of the loadstone in moving iron; not gold, not silver, stone, glass, wood, water, oil, cloth, air, flame, &c,

* See this subject prosecuted in the Author's History of Condensation and Rarifaction.

† See the Author's History of Condensation and Rarifaction throughout.

yet, by an exact scrutiny, some medium may perhaps be found to deaden this virtue more than any other medium, comparatively and in some degree.

Thus suppose the loadstone would not attract iron so much through gold of a certain thickness, as through the same space of air; or not so much through ignited silver, as through the same when cold, &c. For we have not made the trials, but it is sufficient to propose them by way of example*.

In like manner, there is no body found here upon the earth but what is susceptible of heat, when applied to the fire; yet air receives heat much sooner than a stone. And such is the substitution made in the way of degree or approximation.

The substitution by analogy is useful, but less certain, and therefore to be practised with judgment. This is performed when an insensible thing is brought down to the sense; not by the sensible operations of the insensible body itself, but by considering some other sensible body of kin thereto.

For example; if the subject of enquiry were the mixture of spirits, which are invisible substances, we are here to observe, that there seems

* See below, *Aph.* 43.

to be a certain affinity between bodies, and the matter that feeds or nourishes them. Thus oil and fat bodies seems to be the food of flame; and water and aqueous bodies, the food of air; for flames multiply themselves upon the exhalations of oil; and air upon the vapour of water. In this enquiry, therefore, we may consider the mixture of water and oil, which is manifest to the sense, though the mixture of air and flame is not perceptible. Now, oil and water are very imperfectly mixed together by composition, or agitation; but more curiously and elaborately in plants, blood, and the parts of animals, and, therefore, something of the like kind may happen as to the mixture of flame and air in untangible bodies. For, though flame and air do not well incorporate by simple motion, yet they seem to mix in the spirits of plants and animals; the rather, because all animal spirits prey upon both kinds of moisture, viz. the aqueous, the unctuous, as its aliment*.

In like manner, if the subject of enquiry be not the perfect mixture of pneumatical or untangible bodies, but only their composition; viz. whether they will easily mix among themselves; or rather, suppose, for example, certain winds,

* See the Axioms at the close of the History of Life and Death. See also Mr. Boyle's Experiments to this purpose. Abridgm. Vol. II. p. 469.

or exhalations, or other pneumatical bodies, which mix not with common air, but only lodge and float therein, under the form of globules and drops, as being rather broke and ground by the air, than received into and incorporated with it. Now this cannot be perceived by the sense, either in common air, or other pneumatical bodies, by reason of their subtilty or fineness; but a certain image or representation may be had of the thing, with regard to its possibility, in tangible fluids; such as quicksilver, oil, water*, and even in air itself, when it is broke and dissipated, or rises in small particles or bubbles through water; and again, an image of it may be had in the grosser fumes†; and lastly, in dust raised and floating in the air: in all which cases there is no incorporation made. And this representation is not faulty, provided it be first carefully examined, whether among pneumatical bodies there may be such an heterogeneity as is found among liquors; for in case there is, then these representations by analogy may be commodiously substituted‡.

---

* These being heterogeneous fluids, and not mixing together upon shaking.

† Which do not incorporate with the air.

‡ See Mr. Boyle upon the different surfaces of fluids in contact. Abridgm. Vol. I. p. 316—318. and 388—396.

And though, as we before observed, information is to be derived from these supplemental instances, by way of refuge or recourse, when proper instances are wanting; yet we would have it understood, that they are also of great use, even when the proper instances are procurable; particularly in strengthening the information, with the assistance of those. But the time for treating of these instances more exactly is when we come, by the law of order, to the helps of induction *.

43. In the twentieth place come lancing instances, which we also, for a different reason, call by the name of vellicating instances. We call them vellicating instances, because they twitch the understanding; and lancing instances, because they cut or lance through nature; whence we also call them democritical instances †; that is, such as remind the understanding of the admirable and exquisite subtilty of nature, so as to excite and awaken it to attention, observation, and proper enquiry.

For example; the following are lancing or vellicating instances. (1.) That so small a drop of ink in a pen should be drawn out into so many

* A part of the Novum Organum that is wanting. See above, *Part* II. *Aph.* 21.

† Alluding to the Atoms of Democritus. See the Author's Essay upon the Corpuscular Philosophy.

letters or lines, as we find it; (2.) that silver gilt upon its external surface, should be drawn to such a vast length of gilded wire*; (3.) that so very small a worm as that found in the skin, should have a spirit, and a peculiar structure and organization of different parts; (4.) that a little saffron should tinge a whole hogshead of water†; (5.) that a little civet or musk should fill a large chamber with its odour; (6.) that such a great cloud of smoke should be raised from a little incense; (7.) that the exact differences of sounds should be every way conveyed through the air, and even through the holes and pores of wood and water, (though much weakened, indeed, in the passage,) and be reflected with great distinctness and velocity; (8.) that light and colour should so suddenly pass through such a bulk of solid matter, as glass, or of a fluid, as water; yet so as at the same time to convey a great and exquisite variety of images, even though the light suffers refraction and reflection; (9.) that the loadstone should operate through all kinds of bodies, even the most compact and solid; and what is still more wonderful; (10.) that in all these cases the action of one thing does not greatly hinder the action of another, in a neu-

* See Mr. Boyle upon Effluvia, Abridgm. Vol. I. p. 485.

† See Mr. Boyle upon Effluvia, &c. Vol. I. p. 397, 438.

tral or indifferent medium, such as the air is. Thus numberless images of visible objects are carried through the air; numberless percussions of articulate voices; numberless specific odours, as those of violets, roses, &c. even cold, heat, and magnetical virtues, all pass through the air at once, without obstructing one another, as if each of them had its own separate way or passage, so as to prevent impinging against, meeting with, or obstructing one another.

To these lancing instances may be advantageously subjoined those we term the limiting instances, with regard to this lancing; as for example, in the cases just mentioned, that (1.) one action does not disturb or hinder another of a different kind, though two of the same kind damp or extinguish each other; that (2.) the light of the sun extinguishes or over powers the light of the glow-worm; that (3.) the report of a cannon drowns the voice; that (4.) a stronger odour overpowers one that is more delicate; that (5.) a stronger heat prevails over one that is more gentle; and, (6.) that an iron plate put between the loadstone and a needle hinders the magnetic virtue. But the proper place of treating these instances also, is under the helps of induction *.

* A part not entered upon by the Author. See above, *Aph.* 21. and 43.

And so much for the instances of help to the senses, which are of capital use in the business of information, for information begins with the sense *. But the whole affair terminates in practice and works, which are the end; as information is the beginning †. And, therefore, the instances of principal use in practice are next to follow.

44. The instances of principal use in practice are of two kinds, and seven in number; all which we call by the general name of practical instances. Now practice has two inconveniences or defects; and so many general kinds of prerogative instances ‡. For practice either fails or overburdens. Practice fails principally from a wrong determination and measure of the powers and actions of bodies; especially after a diligent enquiry into the subject. But the powers and actions of bodies are circumscribed and measured, either (1.) by space of place §; (2.) by moments of time ‖; (3.) by the correspondence or proportion of quantity ¶; or, (4.) by the predominancy of virtue **: and unless these four things

---

* See above, *Aph.* 38. † See *Part* II. *Aph.* 1.

‡ Viz. Two, corresponding to the two kinds of defects of practice; four defects of the first kind are enumerated in this paragraph, and three of the second in the next.

§ See below, *Aph.* 45. ‖ See below, *Aph.* 46.

¶ See below, *Aph.* 47. ** See below, *Aph.* 48.

are well and diligently weighed, the sciences indeed may, perhaps, be beautiful in show and appearance, but they will remain unfruitful or barren of works. And the four instances, with regard to these four particulars, we call, in general, mathematical instances, or instances of mensuration*.

Practice proves burdensome either (1.) from the admixture of useless things†; (2.) from a multiplicity of instruments‡; or, (3.) from the bulk of the matter, and bodies required, in certain works§. Those instances, therefore, ought to be highly esteemed, which either (1.) direct and determine practice to such things as chiefly regard the benefit and advantage of mankind; or, (2.) retrench the number of instruments required; or, (3.) save and lessen the materials to be employed.

And the three instances corresponding to these three particulars or requisites, we call by the single name of propitious or benevolent instances‖. We shall speak of these seven instances separately; and with them conclude this section of the doctrine of prerogative instances.

45. In the twenty-first place, therefore, among

---

* Which see below, *Aph.* 45—48.

† See below, *Aph.* 49. ‡ See below, *Aph.* 50.

§ See below *Aph.* 51. ‖ See *Aph.* 49—51.

prerogative instances, come instances of the staff, or measuring-rod, which we also call permeating or teminating instances; for the forces and motions of things operate and exert themselves in certain spaces, that are not indefinite or fortuitous, but determinate and finite; and the due observance and marking of these spaces in every nature sought, is of great importance to practice, not only in preventing us from being deceived by it, but also in enlarging and rendering it more extensive and powerful; for it is sometimes possible to extend virtues and powers, and, as it were, bring distances nearer, as we see in telescopes.

There are also many virtues that operate and extend their force only by manifest contact; as in the percussion of bodies, where one body does not move another, unless the impelling body touches the body impelled. So, likewise, external remedies, as unguents and plaisters, exert not their virtues without touching the body. And, lastly, the objects of the taste and touch do not strike or effect, if not contiguous to the respective organs.

There are also other virtues, which operate at a small distance, very few whereof have been hitherto observed, whilst there are more of them than men suspect. Thus, to give obvious ex-

amples, amber and jet attract straws, and other light bodies. Bubbles of water, approaching each other, run together. Some purgative medicines draw the humour downwards, and the like. But that magnetic virtue whereby iron and the loadstone, or loadstones themselves, meet each other, operates only in a certain little sphere of activity, but if there be any magnetic virtue flowing from the inner parts of the earth, to the needle, in respect of its verticity, the operation is performed at a great distance.

Again, if there be any magnetic virtue, which operates by consent, between the globe of the earth, and ponderous bodies; or between the globe of the moon and the waters of the sea, which seems highly probable from the spring tides; or between the sphere of the fixed stars and the planets, so as to attract the planets to their apogees, all these must operate at very great distances.

There are also found certain communications of flame, to considerable distances, in certain materials, as they relate, in particular, of the Naphtha of Babylon. Heat likewise insinuates itself to great distances, and so does cold, insomuch that the huge masses of ice broke off, and floating in the north sea, and thence coming into the Atlantic Ocean, strike a coldness many

leagues off, perceptible to the inhabitants about Canada*.

Odours, likewise, though these seem always attended with a corporeal emission of the odoriferous substance, operate at considerable distances, as appears to such as sail along the coasts of Florida, or some parts of Spain, where there are whole groves or woods of lemons, oranges, and the like odoriferous trees; or thickets of rosemary, marjoram, &c.† And lastly, sounds, but particularly the rays of light, operate to prodigious distances‡.

But all these virtues, whether they operate to small or large distances, certainly operate to finite ones, and such as are known to nature, so that there are certain fixed bounds which they cannot exceed, and that in proportion either, 1. to the bulk and quantity of the bodies; or, 2. to the strength or weakness of the virtues; or, 3. to the suitableness or unsuitableness of the medium, all which ought to be carefully observed, and brought to computation§. And again, the measures of those called violent motions, or

* See Mr. Boyle's History of Cold.

† See Mr. Boyle of Effluvia.

‡ See Mr. Boyle, Dr. Hook, Sir Isaac Newton, the Philosophical Transactions, French Memoirs, &c.

§ Here we may observe the proper use of calculation, or mathematics, in physics.

the motions of projectiles, as bullets from guns, the motions of carriages, &c. ought to be observed and determined, for these also have manifestly their fixed limits.

There are, likewise, certain motions and virtues, contrary to those that operate by contact, and not at a distance, as acting at a distance, and not by contact; and again, others that operate weaker at a small distance, and stronger at a greater. Thus vision is not well performed in contact, but requires a certain medium, and a certain distance, to be perfect; though I have been assured, by a person of veracity, who was couched for cataracts in his eyes, (which is an operation performed by means of a small silver needle, thrust between the first coat of the eye, to remove and force away the film of the cataract into the corner of the eye) that he clearly saw the needle moving over the pupilla, or sight of the eye*.

But allowing this, it is manifest that larger objects cannot be well or distinctly seen, except in the vertex of a cone, made by the converging of the rays from some distance. Thus old men see better when the object is removed a little farther off, than when it is near. And it is certain, that

* See Sir Isaac Newton's Optics, particularly the queries at the end thereof.

in projectiles, the percussion is not so strong at too small a distance, as it is soon after, or at the due distance. The measures, therefore, of these things, and others of the like kind, are to be set down, to determine their motion in point of distance.

We must not omit another kind of local measure of motions, which regards not progressive, but spherical motion; that is, the expansion of bodies into a larger sphere, or their contraction into a less. For we should enquire, among the measures of motion, what degree of compression or extension bodies, according to their nature, may easily and readily suffer, and at what point they begin to resist, and at length will sustain no more. Thus when a blown bladder is compressed, the air sustains some degree of compressure, but if the compressure be too great, the air enduring it no longer, bursts the bladder, and frees itself.

But to make a more exact experiment to this purpose, we took a small, light, and thin metalline bell, and plunged it into a bason of water, so that it carried down along with it the air contained in its cavity, to the bottom of the vessel, where we had first placed a little ball, which the cavity of the bell was to fall upon. When this ball was little in proportion to the cavity of the bell, the air shrunk itself into a less compass, without

escaping; but if the ball was so large, that the air could not freely yield, the air would then, as being impatient of a greater pressure, raise up the bell, on one side, and ascend in bubbles*.

Again, to try what degree of extension air is capable of, we took a glass egg, with a small orifice at one end thereof, and by strong suction drew out the air, then immediately stopping the orifice with the finger, we plunged the glass in water, where the finger being removed, the air that was stretched and dilated by the suction, now endeavouring to contract itself, (so that if the glass had not been plunged in water, it would have drawn in the external air with a hissing noise) it drew in such a quantity of water as sufficed to recover the remaining air to its former bulk or dimension†.

And it is certain, that pneumatical, or rare bodies, such as the air, will suffer a remarkable contraction; but that tangible bodies, such as water, suffer compression with much greater difficulty, and in a less degree. What this degree might be, we attempted to discover by the following experiment.

---

* The design was here, to estimate the force wherewith air resists its own condensation, or endeavour to escape. See Mr. Boyle's Pneumatical Experiments, particularly Abridgm. Vol. II. p. 670—672.

† See Mr. Boyle's Works, Abridgm. Vol. II. p. 414.

We caused a hollow and strong globe of lead to be formed, capable of containing two wine pints, and having made a hole therein, we filled the globe with water, then soldered up the orifice with lead, and now beat the sides of the globe flat out with a large hammer; whence the water was of necessity contracted, because a sphere is the figure of largest capacity. And when hammering was of no farther service in making the water shrink, we put the lead vessel into a press, and squeezed it, till at length the water forced itself through the solid lead, and stood upon its surface like a dew. We afterwards computed into how much less space the water was driven by this violent pressure*.

But solid, dry, or more compact bodies, as stones, wood, and metals, sustain a much less, and almost imperceptible compression and extension, and either release themselves by breaking, moving, squeezing out, or other evasions, as appears in the bending of wood or metal, in spring clocks or watches, in projectiles, hammering, and numerous other motions.

But all these particulars, together with their measures, are to be discovered and set down, in

* See the Experiments of the *Academie del Cimento*; and Mr. Boyle's Works, Abridgm. Vol. I. p. 628, 629, Vol. II. p. 290, 666, 703, &c.

the enquiry into nature, either in the way of certain calculation, estimation, or comparison, as the case will admit.

46. In the twenty-second place, among our prerogative instances come instances of the course, or stage, which we also sometimes call hydrometrical instances*, deriving the term from the hour-glasses of the ancients, wherein they used water instead of sand. These instances measure nature by moments of time†, as the instances of the staff‡ measure them by degrees of space. For all motions, or natural actions, are performed in time; one indeed swifter, and another slower, but all in certain moments well known to nature. Even those actions which seem suddenly performed, or in the twinkling of an eye, as we phrase it, are yet found to differ in time, as to more or less.

And, first, we see that the revolutions or returns of the celestial bodies are performed in certain times or periods, so likewise is the flux and reflux of the sea. The descent of heavy bodies towards the earth, and the ascent of light bodies towards the heavens, is performed in certain moments, according to the nature of the body, and

---

* As if it were instances of the time-keeper, or hour-glass

† See above, *Aph.* 44. ‡ See above, *Aph.* 45.

the medium it moves in. The motions of a ship, in sailing; of a horse, or other creature, in running; of a projectile, in flying, &c. are all, in like manner, performed in certain times, measurable in the amount or result. And, with regard to heat, we see that boys, in the winter, will wash their hands in the flame of a common fire, without burning themselves; and, in the way of sport, others will, by a nimble and equable motion, turn glasses of wine, or water, upside down, and recover them again, without spilling; and there are many particulars of the same kind.

So likewise some compressions, dilatations, and eruptions, or explosions of bodies, happen swifter, and others slower, according to the nature of the body and the motion, but they happen in certain moments of time. Thus, in the joint explosion of several large cannons, which may be heard sometimes to the distance of thirty miles, the report is first audible to those near the place, where the discharge is made, and afterwards to those who are farther off*.

And in vision, where the action is exceeding swift, it is plain that certain moments of time are required to its performance, as is plain from hence, that bodies are rendered invisible through

* See Mr. Whiston's second edition of his Essay upon the Longitude; and Dr. Derham's Paper upon the Motion of Sounds, in the Philosophical Transactions, No. 313.

too great a velocity of motion, as in the discharge of a bullet from a gun, where the ball flies too swift to have its impression received by the eye.

And, upon comparing this with the like cases, we have sometimes entertained a strange suspicion, viz. whether the stars of a clear sky be seen by us at the precise time they really exist, or rather somewhat later; and whether there be not, with regard to the sight of the heavens, a true and apparent time, as well as a true place, and apparent place, which is observed by the astronomers in the parallaxes. For it seems incredible that the rays of the celestial bodies should instantly travel such an immense distance to the sight, and not rather take up some considerable time in the journey *.

But this suspicion, as to any great interval betwixt the real and apparent time, afterwards vanished, upon considering that infinite loss and diminution of quantity, as to sight, between the real body of a star, and the apparent object, which difference is caused by the distance; and, at the same time, considering to what a distance objects that are barely white may, of a sudden,

* See this time computed by *M. Huygens de la Lumiere*, p. 8 and 9. See also Sir Isaac Newton upon the subject; and compare them both with the Papers of M. Maraldi in the French Memoirs, Ann. 1707.

be seen here below, amounting to sixty miles at the least*; for there is no question but that the light of the celestial bodies has not only the vivid strength of whiteness, but also vastly exceeds the light of flame, as we find flame here in power and strength of radiancy. Nay, that immense velocity wherewith gross matter moves, in the diurnal rotation, renders this wonderfully swift motion of the rays of light, from the fixed stars, more probable. But what has the greatest weight with me, is this, that if there should here be any considerable space of time between reality and sight, or the existence of the object, and its being seen, it must then happen, that the sight would be frequently intercepted and confounded by clouds arising in the mean time, or by the like disturbances in the medium. And thus much for the simple mensuration of time.

The measure of motions and actions is not, however, to be sought only simply, but much rather comparatively, this being a thing of excellent use, and having regard to very many particulars. We find, that the flash of a great gun is seen before the sound is heard, although it is certain that the bullet must strike the air before the flame, which was behind it, could get out; and that this must happen from a greater velocity in

* See again, Mr. Whiston's Essay upon the Longitude.

the motion of light, than in the motion of sound. We find also, that visible objects are sooner received than let go by the sight, whence it is that the strings of a musical instrument, struck with the finger, appear double, or treble, in the vibration, viz. because a new object is received before the other is discharged; and for the same reason, rings twirling upon an axis seem spheres; and a lighted flambeau, carried hastily by night, appears tailed, like a comet.

And, from this foundation of the inequality of motion in point of velocity, Galilæo imagined the cause of the flux and reflux of the sea to be from the earth's revolving with a greater velocity than the waters; whence the waters gathering into a heap upwards, afterwards sunk down by degrees, as we see in a vessel of water briskly revolved. But this solution he invented barely upon supposition, and not upon proof, of the earth's motion, and also without being well informed of the sexhorary motion of the sea.

But we have an eminent example of the comparative measure of motion, and at the same time of its remarkable use in the business of powder-mines, wherein vast masses of earth, piles of buildings, &c. are overturned, and tossed into the air with a small quantity of gunpowder. The cause whereof is doubtless this, that the motion of dilatation in the powder, which is the im-

pelling force, is many degrees swifter than the motion of gravity, which makes the resistance, so that the prevailing motion is performed before the opposite motion begins, whilst at first there was a kind of neutrality, or want of resistance. And hence, in all projectiles, it is not so much the strong as the sharp and quick stroke, or percussion, that carries the body farthest. Nor was it possible that a small quantity of spirit in animals, especially in those so bulky as the elephant, or the whale, should move and manage so great a mass of matter, but for the velocity of the motion of the spirit, and the inability of the corporeal mass to resist.

And this is one of the principal foundations of the magical instances, which we shall soon consider*, wherein a small quantity of matter overpowers and subdues a much greater; that is, where there may be a pre-occupation, or anticipation of motions, by the velocity of one, before another is ready†.

Lastly, this business of anticipation and subsequence should be observed in all natural actions. Thus in the infusion of rhubarb, the purgative virtue is drawn out first, and the astrin-

* See below, *Aph.* 51.

† This deserves to be carefully considered and remembered; for many extraordinary operations and cases of practice, depend upon it.

gent virtue afterwards *. And something of the like kind we have found upon infusing violets in vinegar †, where the sweet and delicate odour of the flowers is first received, and afterwards the more earthy part, which confounds the odour; therefore, if violets be infused for a whole day, their smell is obtained much fainter than if they were infused only for a quarter of an hour, and then taken out. And because violets contain but little odoriferous spirit, if fresh ones be infused in the same liquor, every quarter of an hour, for six times, the tincture, or infusion, will become so rich in the space of an hour and a half, as to continue, for a whole year, of an exceeding grateful odour, not inferior to the flowers themselves. But it must be observed, that the odour does not come to collect its full strength, till a month after the infusion is made. And the business of distillation affords numerous remarkable examples to the same purpose.

47. In the twenty-third place, among prerogative instances, come instances of quantity, which we also call the doses of nature ‡, borrowing the expression from medicine. These are such instances as measure virtues by the quantities of bodies, and indicate what the quantity of a body contributes to the quantity of virtue.

---

* See the *Sylva Sylvarum*, under the article Infusion.

† See the last cited. ‡ See above, *Aph.* 44.

And, first, there are certain virtues subsisting only in a cosmical quantity; that is, such a quantity as has a consent with the configuration and structure of the universe. Thus the whole body of the earth, unmoved suppose in its whole, does not fall downwards, though its parts do; the waters ebb and flow in the sea, but not in rivers, unless where they communicate with the sea; and almost all particular virtues operate in proportion, as the body is bigger or less. Large collections of water do not easily corrupt, as small ones do. New wines and drinks ripen quicker, or become sooner potable, when contained in small vessels, than when in large ones. If a plant be added to a large proportion of liquor, it makes an infusion rather than a tincture; but if to a less, it makes a tincture rather than an infusion. So, with regard to the human body, bathing is one thing, but sprinkling another. And thus the finest dews never fall in the air, but are dissipated and incorporated with it. And we see in breathing upon polished gems, that the small quantity of moisture thus left upon their surface, is presently licked up by the air, as a light cloud, or mist, is dissipated by the wind. Again, a piece of loadstone will not attract so much iron as the whole loadstone would do.

There are also virtues, wherein smallness of quantity has the greatest effect, as a sharp point penetrates easier than a blunt one, and as the angular point of a diamond cuts glass; with other examples of the like kind.

But we are not here to dwell upon indefinites, but should enquire into the proportions of the quantity of a body, with regard to the measure of its virtue, for one might easily imagine, that the proportions of quantity corresponded to the proportions of virtue, as that a leaden bullet of two ounces should fall twice as swift as another of one ounce, which is absolutely false. Nor do the same, but very different proportions obtain in all kinds of virtues; and, therefore, these measures must be derived from experiments, and things themselves, and not from probabilities or conjectures.

Lastly, in every natural enquiry, the quantity of the body required to produce any effect must be set down, as the dose, and the cautions, with regard to quantity, either in excess or defect, continually interspersed.

48. In the twenty-fourth place come instances of reluctance, which we also call by the name of prevailing instances; that is, such as shew the predominancy, or subjection of virtues to one another, or which of them is the stronger and

prevails, and which the weaker and submits; for the motions and struggles of bodies are no less compounded, recompounded, and complicate, than bodies themselves. We will, therefore, first lay down the principal species of motions, or active virtues, that their comparison, in point of strength, may be the clearer; and thence the instances of reluctance and prevalence be the better known and designed.

The first motion may be the motion of resistance in matter, or the motion that resides in all the parts thereof, and will not suffer it to be any way annihilated; so that no force of fire, no weight or depression, no violence, no length of time, or continuance of duration, can ever possibly reduce any the least particle of matter to nothing, but it will still continue something; possess a certain space, and, to whatever necessity it be reduced, free itself, either by changing its form or place, or, if it cannot do that, it will continue as it was, so that the time shall never come when it is nothing, or has no existence. And of this motion we need produce no examples, because it is universal, or exists in all bodies *.

Let the second motion be that we term motion of connection, whereby bodies suffer not

* See the Author's History of Condensation and Rarifaction.

themselves to be divided, or separated from others, on account of the mutual contact and connection they affect, which is a motion called by the schools the motion preventive of vacuity, as when water is forced upwards by suction, or by the pump, or when the flesh is raised by cupping-glasses, or as when water runs through a siphon, with numerous other examples of the the same kind*.

Let the third motion be what we call motion of liberty, or freeing motion, whereby bodies endeavour to ease and free themselves from any preternatural pressure or tension, or restore themselves to the dimensions agreeable to their own natures. And of this motion also the examples are numerous. Thus water endeavours to free itself from pressure in the action of sailing and rowing; the air, in the action of flying, and in the undulations of the winds; the springs in watches; compressed air in pot-guns, which forces out the pellet, &c.

And, for this motion of liberty in the case of tension, we see the air frees itself therefrom, when it remains after suction in glass eggs †; we see it also in strings, leather, cloth, &c. which

* Let it be considered, whether all these motions are justly explained by the weight, spring, or pressure of the air.

† See above, *Aph.* 45.

restore themselves after tension, unless where they remained so long stretched, as to have their motion of liberty subdued. This motion is unscientifically called, by the schools, the motion of the elementary forms; for it does not only belong to air, water, and flame, but to all the diversities of consistent bodies, as wood, iron, lead, cloth, skins, &c. each body having its own measure of extent or dimension, from whence it is with difficulty stretched to any considerable distance*.

But as this motion of liberty is, of all others, the most obvious, and also extremely general, it requires to be well and clearly distinguished; for some very inadvertently confound it with the motion of resistance and the motion of connexion. Thus when, by this motion, matter frees itself from pressure, they confound it with the motion of resistance; and when matter frees itself from tension, they confound it with the motion of connexion; as if compressed bodies yielded or dilated themselves only to prevent a penetration of dimensions; and as if, when stretched, they restored or contracted themselves, to prevent a vacuum; whereas if compressed air were to become as dense as water

* See the History of Condensation and Rarifaction; and the article Motion in the *Sylva Sylvarum*.

or wood as dense as stone, there would be no danger of a penetration of dimensions, even though these bodies could be much farther compressed than they any way admit of. So likewise, if water were to be dilated to the same degree of rarifaction with air, or stone to the same degree of rarifaction with wood, there is no necessity that a vacuum should ensue, even though these bodies could be extended much farther than their natures any way allow*. And therefore the case is not brought to a penetration of dimensions and vacuity, except in the utmost limits of condensation and rarifaction; whereas these motions stop far short of those limits, as being no more than appetites which bodies have of continuing themselves in their own consistencies or dimensions, and not suddenly departing from them, unless altered by gentle means and by consent.

But it is much more necessary, as being a thing of great consequence, to observe that violent motion, as it is called, is no other than this very motion of liberty, tending from compression to relaxation. For in all simple protrusion, or flight through the air, there is no tendency to motion or change of place before the parts of

* See the Author's History of Condensation and Rarifaction.

the body suffer preternaturally, and are compressed by the impelling force; whence it is that some parts successively pressing against the rest, the whole body is driven off, or protruded; and not only in a progressive, but at the same time in a rotatory or revolating motion, so as that by this means also the parts may free themselves, or suffer more equally.

Let the fourth motion be the motion of extension; which is, in some measure, the opposite to the motion of liberty; for in the motion of liberty, bodies avoid, dread, and fly from a new dimension, or a new degree of dilatation or contraction, and endeavour, with all their force, to recover their former state; whereas, on the contrary, in the motion of extension, bodies affect a new dimension, and sometimes willingly and hastily aspire to it, even with a violent endeavour, as we see in gunpowder. And the most powerful, or at least the most common, though not the only instruments of this motion, are heat and cold.

For example, if air be dilated by tension, as it is in suction, it has a great appetite of restoring itself; but if heat be applied thereto, it, on the contrary, tends to dilate, and occupy a new dimension, and goes willingly over thereto, as into a new state, and after some continuance of this dilatation, it has no great appetite to return, un-

less solicited thereto by the application of cold, which is no spontaneous return, but a repeated change.

So likewise water, when compressed, resists and endeavours, as it were, to enlarge itself; but upon the continuance of intense cold, it spontaneously and readily concretes into ice; and if the cold continues very long, without interruption from any warmth, as perhaps sometimes happens in the deeper caverns, the water is turned into crystal, or matter approaching thereto, and never recovers the nature of water again *.

Let the fifth motion be the motion of continuity; by which we do not mean a simple and primary continuation with any other body, for that is motion of connexion, but of self-continuation in a certain body. For it is manifest, that all bodies resist a solution of their continuity; some indeed more, and others less, but all of them in a degree. And, as in hard bodies, such as steel and glass, the resistance of discontinuation is very strong; so likewise in liquors, where this motion seems either to cease, or at least to languish, yet it is not absolutely wanting, but it plainly resides in them, as it were, in the lowest degree, and discovers

* See the *Sylva Sylvarum*, under the article Transmutation. See also Mr. Boyle, upon the Origin of Gems.

itself by numerous experiments; as particularly in bubbles; the sphericity of drops; the fine threads of isicles; in the drawing out of glutinous bodies, &c. But this appetite principally appears, when a discontinuation is attempted in the small parts of bodies: thus, in beating the mortar, after the pulverization is carried to a certain degree, the pestle operates no further upon the matter to reduce it finer. And so water will not enter into fine cracks, or fissures; nor air, though so extremely subtile, readily insinuate into the pores of solid vessels.

Let the sixth motion be that we call motion of acquisition, or motion of want; by which bodies, when placed among others that are heterogeneous to, and, as it were at enmity with them, if they find an opportunity of flying and avoiding these, and applying themselves to others nearer related, though without any close or intimate consent, yet they presently embrace the occasion, and chuse the latter before the former, as it were, in the way of acquisition, or as if they stood in want of such bodies, from whence we derive the name.

For example, leaf-gold, or any other metal in the leaf, delights not in the ambient air; and therefore if it touches any tangible or gross body, as the finger, paper, &c. it presently sticks thereto, and is not easily separated again.

So paper, cloth, &c. have no great agreement with the air residing or lodged in the pores thereof, and therefore such bodies readily imbibe water or other moisture, and reject or throw out the air. So if sugar or sponge be dipt only at one end in water or wine, whilst the other part remains far above the surface of the liquor; yet these bodies gradually attract the wine and water upwards *.

Hence we may derive an excellent rule for the opening and dissolving of bodies; for, (not to meddle at present with corrosive menstruums, which force themselves a passage) if a suitable body can be found that has a greater agreement or consent with any solid, than the matter has wherewith such a solid is mixed, as it were by necessity †; the solid will immediately open and relax itself, to receive the latter and exclude and reject the former ‡. Nor does this motion of acquisition operate only in immediate contact,

* See the *Sylva Sylvarum*, under the article Attraction.

† The Instances hereof are numerous in chemistry, as in adding oil of vitriol to nitre, sea-salt, &c. when the oil of vitriol seizes upon the earthy part, and sets the spirit of nitre, &c. free.

‡ See the article Attraction in the *Sylva Sylvarum*. See also the chapter of Menstruum in Boerhaave's Chemistry; and M. Geoffroy's Table of the different relations observed in Chemistry, betwixt different bodies, in the French Memoirs. Ann. 1718.

for the electrical virtue (about which Dr. Gilbert and others have invented such fables) is an appetite excited by a gentle friction, and not well agreeing with, or enduring the air, but affects or covets other tangible bodies, if it finds them near at hand *.

Let the seventh motion be that we call the motion of the greater congregation, whereby bodies are carried to the masses of their own natures; heavy ones to the globe of the earth, and light ones to surrounding heavens. This, by the schools, from a superficial consideration, is called natural motion; because they found nothing that was externally visible to give it, and therefore imagined it to reside naturally, or to be innate in things themselves: or again, perhaps because it is a ceaseless or continual motion. And no wonder, since the heavens and the earth are always at hand; whereas the causes and origins of many other motions are sometimes present and sometimes absent; and hence they laid this down for a constant and proper motion, and the others for acquired ones.

But, in reality, this motion is weak and languid, as yielding and submitting to other motions, so long as they continue to operate, un-

* See Mr. Boyle of Electricity. See also the Author's *Sylva Sylvarum*, under the article Electricity.

less the bulk of the body be considerable. And although this motion has so possessed the thoughts of men as almost to have stifled or superseded the rest; yet it is very little that they know thereof, but run into many errors about it *.

Let the eighth motion be the motion of the lesser congregation, whereby the homogeneous parts in any one body separate themselves from the heterogeneous, or collect together, and whereby also distinct and entire bodies, from a similitude of substance, embrace, cherish, and sometimes collect and attract each other, and come together from a certain distance, as when in milk, the cream after some continuance floats a-top; and in wine, the lees sink to the bottom. Nor does it happen only through the motion of gravity and levity, that some parts should rise to the top, and others sink to the bottom; but much more through an appetite, that homogeneous bodies have of meeting and uniting together.

This motion differs from the motion of want in two respects; the one, that in the motion of want there is a stimulus, or incitement of a malignant and contrary nature, whereas in this motion, when all obstacles and impediments are removed, the parts unite by congruity or affec-

* See the article Motion in the *Sylva Sylvarum*.

tion, though there be no foreign nature present to cause an aversion. The other respect is, that the union here proves closer, and, as it were, stronger, with greater appetite or choice. For, in the former, if the thing at enmity be avoided, the bodies meet, though they are not greatly related; but in the latter, substances come together, as if perfectly related by similitude, and make, as it were, one whole. And this motion resides in all compound bodies, and would easily shew itself in each, if it were not bound down and restrained by other appetites, and necessities of bodies, which disturb and hinder this union*.

This motion is generally bound down three ways, viz. 1. by the inactivity of bodies; 2. by the check of a predominating body; and, 3. by external motion. As to the first, it is certain that tangible bodies have a kind of inactivity or sluggishness, in a greater or less degree, whereby they dread or resist local motion, so that, unless excited, they tend rather to continue in their present state, than to move or change for a better†.

* These appetites, or laws of motion, require the strictest regard, as being the things whereon all the actions and passions, or all the phænomena and effects of bodies, principally depend.

† This seems to be what is now called, by mathematical writers, the vis inertiæ of matter.

This sluggishness is taken off by three means, viz. 1. either by heat; 2. some eminent virtue of a body related; or, 3. by a brisk and powerful motion. And, first, as to the assistance of heat, it hence arises, that heat is said to separate heterogeneous and congregate homogeneous bodies, which is a definition of the peripatetics, justly derided by Dr. Gilbert, as being like the defining a man to be a thing that sows corn, and plants vineyards, a definition formed only upon particular effects. But the former definition is still more faulty, because the effects, whatever they are, proceed not directly from the property of heat, but only by accident, for cold will do the same, as we shall shew hereafter*, and is really owing to an appetite which the homogeneous parts have of coming together, the heat only assisting to dispel the sluggishness that before subdued or bound down this appetite.

Secondly, as to the assistance of the virtue communicated by a body related, this appears surprisingly in the armed loadstone, which excites in iron a virtue of detaining iron, by similitude of substance, the virtue of the magnet here dispelling the sluggishness of the iron.

And, thirdly, for the assistance of motion, we see it in arrows of wood, with wooden points,

* As particularly, in the freezing of brandy, wine, saline liquors, &c. See below, *Aph* 50.

which penetrate farther into wood than if they were tipt with iron, through a similitude of substance, the inactivity of the wood being shook off by the velocity of the motion, as we before observed, under clandestine instances*.

The binding of the motion of the lesser congregation, by the check of a predominating body, appears in the resolution of blood, and urine, by cold, for so long as these fluids continue full of that active spirit which directs, governs, and subdues their parts, of every kind, as lord of the whole, so long the different parts do not collect together, by reason of the check upon them; but after this spirit is evaporated, or deadened by cold, then the parts being relaxed and unbridled, severally come together, according to their natural appetites. And hence it is that all bodies, containing a sharp spirit, as salts, and the like, continue unseparated†, viz. by reason of the permanent and durable check of the presiding, or over-ruling spirit.

We have an eminent example of the motion of the lesser congregation being subdued by external motion, in the agitations of bodies, which are preventive of putrefaction; for all putrefac-

* See above, *Aph.* 25. See also the *Sylva Sylvarum*, under the article Attraction.

† Viz. Unresolved into their different principles, or heterogeneous parts.

tion depends upon the uniting of the homogeneous parts, whence there gradually ensues a corruption or destruction of the former state or appearance, and the introduction of a new one; for a solution of the old state must precede putrefaction, which paves the way to the generation of a new thing. And this solution is the collection of the homogeneous parts together, and if not obstructed, the solution is simple; but if various obstacles intervene, putrefaction ensues, that is the rudiments of a new generation. But if a frequent agitation be made, by external motion, then the motion of union, which is here delicate, soft, and requires rest from without, becomes disturbed, and ceases, as we find by numerous examples.

Thus the continual agitation, or running of waters, prevents their putrefying; winds purge and purify a pestilential air; corn, by being turned and agitated, is kept sound in the granary; and, in short, all things that are kept in agitation from without, do not easily putrefy from within*.

We must not here omit that conjunction of the parts of bodies, from whence hardness and dryness principally proceed; for after the spirit, or moisture turned into spirit, is fled from any po-

* See the *Sylva Sylvarum*, under the article Putrefaction.

rous body, as wood, bone, parchment, &c. the grosser parts forcibly contract, and come together, whereupon hardness or dryness ensues, which we judge not to proceed so much from the motion of connection, as from the motion or appetite of amity or union.

As for the motions that meet from a distance, these are extraordinary and uncommon, yet may be found in more things than have been usually observed. We find examples hereof in bubbles, that rush into and dissolve one another; in medicines, that attract or drain off humours by similitude of substance*; two violins in unison with each other, when the one being struck, the other will move, &c. We likewise suspect this motion prevails in the spirits of animals, though it remains perfectly unknown. It is doubtless exerted in the loadstone, and animated iron.

But with regard to the loadstone, there are four distinct motions, virtues, or operations, that should not be confounded, though through admiration and astonishment, men have blended them together. The first is, the attraction betwixt magnet and magnet, iron and the magnet, or animated iron and iron. The second is, the verticity of the touched needle, or its property

* Viz. As rhubarb does the bile, &c.

of pointing north and south, together with its variation or declination from that direction. The third is the virtue of penetrating gold, glass, stone, &c. And the fourth is the communication of virtue from the stone to iron, and from iron to iron, without a communication of substance*. But, at present, we speak only of the first of these virtues, that of approach or attraction.

There is also a remarkable motion of attraction between quicksilver and gold, so that gold will attract quicksilver, though it be made up into ointments. And those that work much among the vapours of quicksilver, commonly hold a piece of gold in their mouths, to collect the mercurial effluvia, which would otherwise penetrate the skull, and bones of the body, &c. and the gold so employed soon after becomes white†. And so much for the lesser congregation.

Let the ninth motion be magnetical motion, which, though a thing of the same kind with the

---

* See the article Magnetism, in the *Sylva Sylvarum*.

† It has been lately questioned, whether, when persons have been salivated by mercury, a piece of gold will be whitened by being held, for several hours, to any part of the body, where no mercury from without is supposed to come, or none besides what has passed through the course of circulation, along with the animal juices.

motion of the lesser congregation, yet, if it operate to great distances, and upon large masses of matter, it deserves a separate enquiry, especially if it neither, like most other motions, begins with contact, nor comes to that at last, as all the motions of congregation do, but only raises bodies, or makes them swell, without any farther effect. For if the moon raises the waters, or makes moist things swell; or if the sphere of the fixed stars attracts the planets, towards their apogees; or if the sun attracts Venus and Mercury, and keeps them always near its body, these motions seem not justly to fall under those of the greater or less congregation, but to be certain middle and imperfect motions of assemblage, that should therefore constitute a particular species.

Let the tenth motion be the motion of avoidance, which is a motion contrary to that of the lesser congregation, and makes bodies, by antipathy*, fly from and keep off others that are disagreeable to them, or separate themselves therefrom, or refuse to mix therewith. For although this motion may seem, in some cases, to be only

* Let it always be remembered, that the Author constantly chuses the old words, where he may use them so as to convey his own meaning with any tolerable advantage. This is the more necessary to be remarked, because men are extremely apt to take particular disgusts, as well as particular likings, to words and phrases.

an accidental, or a consequential thing, with respect to the motion of the lesser congregation, as homogeneous bodies cannot come together, till such as are heterogeneous be excluded and removed; yet it should be particularly mentioned, and made a species, because in many things the appetite of repulsion seems more capital than the appetite of attraction.

This motion appears remarkably in the excretions of animals, and no less in the objects odious to some of the senses, particularly to the smell and taste; for a fetid odour is so repulsed by the organ of smell, that it even causes a motion of expulsion, by consent, in the mouth of the stomach*. A bitter and horrid taste is so repulsed by the palate and throat, as to cause, by consent, a particular shake, or shuddering of the head.

This motion of avoidance has also place in other things, for it appears in some kinds of antiperistasis. Thus the cold in the middle region of the air, seems to be a repulsion of the cold from the confines of the celestial bodies, as those great heats and burnings, found in subterraneous places, seem to be a repulsion of heat from the inner parts of the earth. For heat and cold destroy each other when their degrees are small;

* Viz. A retching.

but when collected into large masses, or, as it were, into full armies, they violently repel, and displace each other in the conflict.

It is also reported, that cinnamon, and other odoriferous bodies, suspended in a jakes, or other fetid place, retain their scent longer, as thus keeping themselves within, and refusing to mix with matters of an ill odour. And quicksilver, which of itself unites into a continued mass, is, by grinding with a little spittle, turpentine, &c. kept asunder, so that its parts unite not again, by reason of the aversion they have to the bodies employed, from which, as every way mixed in among them, they shrink, and shut themselves up, their appetite of avoiding these particles interposed being greater than their appetite of uniting with their own similar parts; and this is what they call the killing of quicksilver.

So again, the reason that oil will not mix with water is not so much owing to their difference of gravity, as to their want of consent, which appears from hence, that spirit of wine, though lighter than oil, yet mixes with water. But the motion of avoidance is most remarkable in nitre, and the like crude bodies, which fly from flame, as we find in gunpowder, quicksilver, and gold *.

* Viz. Quicksilver confined and heated, and in the Aurum Fulminans.

Let the eleventh motion be the motion of assimilation, motion of self-multiplication, or motion of simple generation. By simple generation we do not understand the generation of entire bodies, such as plants and animals, but of similar bodies, so that by this motion bodies convert other bodies related to them, or at least such as are well disposed and prepared to be converted into their own substance and nature.

Thus flame multiplies itself upon unctuous exhalations and oily bodies, and generates new flame; air multiplies itself upon water, and produces new air; and the vegetable and animal spirit multiplies itself, or feeds upon the soft, aqueous, and oleaginous parts, and begets new spirit; the solid parts of plants and living creatures, as the leaves, the flowers, the flesh the bones, &c. are all assimilated from the juices of the aliment, and thus beget new matter, and new substance upon themselves successively *. For let no one dream, with Paracelsus, (who appears as if blinded by his distillations,) that nutrition is performed merely by separation; and that the eyes, the nose, the brain, the liver, &c. lies concealed in bread or food; or that the roots, the leaves, and flowers of vegetables, are lodged

* See the History of Life and Death, the History of Winds, and the *Sylva Sylvarum*.

in the juice of the earth; for he asserts, that as the workman, by separating and paring off what is superfluous from a rude block of stone or wood, educes out of it a leaf, a flower, an eye, or a nose; so the Archæus, that internal operator of his, produces all the different limbs and parts out of the aliment, by separation and rejection.

But to leave such trifling; it is certain, that all the parts, as well similar as organical, in vegetables and animals, first attract with some election or choice, nearly the same common, or not very different juices, for their aliment, and afterwards assimilate or convert them into their own nature*.

Nor is this assimilation, or simple generation, performed only in animate bodies, but inanimate bodies also partake thereof; as was formerly observed of flame and air†. And even the languid spirit contained in all tangible inanimate bodies constantly endeavours to digest the grosser parts, and turn them into spirit to be afterwards discharged; whence proceeds diminution of weight and dryness, as was formerly observed‡.

Nor must we, in the business of assimilation, reject that accretion commonly distinguished

---

* See the *Sylva Sylvarum*, under the article Vegetation.

† See above, *Aph.* 42.

‡ See above, *Aph.* 40.

from assimilation; as when clay, mixed among stones, concretes, and is turned into a stony matter; or when the scales of the teeth are turned into a substance as hard as the teeth themselves, &c. For we judge that all bodies have an appetite of assimilating, as well as of uniting what is homogeneous to themselves, but that both powers are bound down or suppressed, though not in the same manner. All these ways of binding, and the correspondent ones of loosing, should be diligently enquired after, because they regard the prolongation of Life, or the alleviation of old age*.

Lastly, it is worth observing, that in the ten preceding motions bodies seem only to affect or endeavour the preservation of their own natures; but in this eleventh, to endeavour their propagation.

Let the twelfth motion be the motion of excitation; which seems of the same kind with the motion of assimilation, as being diffusive, communicative, transitive, and multiplicative, like that, so as generally to agree therewith in the effect, though they differ in the subject and manner of effecting; for the motion of assimilation proceeds with a kind of sway, authority, and power, as it commands and compels the matter assimilated to turn and change into the matter

* See the author's History of Life and Death.

assimilating; whereas the motion of excitation proceeds as if it were by art, insinuation, and stealth; thus soliciting and disposing the excited matter to assume the nature of the matter exciting. So, again, the motion of assimilation multiplies and transforms bodies and substances, and thus produces more flame, more air, more spirit, more flesh, &c. but in the motion of excitation none but virtues are multiplied and communicated; whence there is generated more heat, more magnetism, more putrefaction, &c.

And this motion is remarkably found in heat and cold; for heat does not diffuse itself in heating, by the communication of the original heat, but only by exciting the parts of the body to that motion which is the form of heat, as was mentioned above *, and therefore heat is much slower and more difficultly excited in stone or metal than in air, by reason of the indisposition and unfitness of those bodies to admit of that motion; whence, possibly, there may lodge in the bowels of the earth matters which cannot be heated, as being, by a greater condensation, deprived of that spirit with which this motion of excitation generally begins †.

---

* See *Aph.* 13. and 20.

† Consult the tables above laid down, *Aph*, 11, 12, 13, 18, 20.

So the magnet gives iron a new disposition of parts and a conformable motion, whilst itself loses nothing of its virtue. So likewise bakers leaven, yeast, rennet, and certain poisons, respectively excite and solicit a successive and continued motion, in the coming of cheese, the making of bread, the fermenting of beer, and in poisoning the human body; and this not so much by the power of the exciting matters, as by the predisposition and easy yielding of the bodies excited.

Let the thirteenth motion be the motion of impression, which likewise seems of the same kind with the motion of assimilation, and is the most subtile of diffusive motions; but we think proper to make it a species by itself, because of a remarkable difference it has in respect of the two former. For the simple motion of assimilation transforms bodies themselves, so that if what gave the first motion be removed, it is of no significance to what follows; for the first lighting up of flame, or the first conversion into air, makes nothing to the succeeding generation of flame or air. So likewise motion of excitation remains perfect for a considerable time after the first mover is taken away, as in a heated body, after what gave the first heat is removed; in animated iron, after the loadstone is laid aside; and in bread before baking, when the leaven is taken away. But the motion of impression,

though it be diffusive and transitive, yet seems constantly to depend upon the first mover, so as if that be taken away, it immediately ceases, and comes to nothing. This motion is, therefore, performed momentaneously, or at least suddenly, for which reason we call the motions of assimilation and excitation the motions of Jupiter's generation, because the generation remains; but this motion of impression, the motion of Saturn's generation, because the offspring is presently devoured and swallowed up.

This motion shews itself in three things, viz 1. the rays of light; 2. the percussion of sounds; and, 3. the communication of magnetical virtues. For, 1. when light is removed, colour and all visible appearances immediately vanish; and, 2. upon removal of the first percussion, and the concussion of the body consequent thereto, sound soon vanishes. For although sounds are tossed and agitated in their medium by winds, as it were by waves, yet it must be carefully observed, that sound does not continue so long as the resounding continues. For when a bell is struck, the sound seems to continue a good while after, but it would be very erroneous hence to conceive, that the sound fluctuated, and hung in the air, all that while; for the resounding is not the same numerical sound, but a new one, as appears plainly by stopping the body struck, so if the

bell be strongly compressed whilst it resounds, and be thus rendered motionless, the sound instantly ceases, and no more resounding is heard. So likewise in stringed instruments, if the string be touched with the finger, after the first percussion, the resounding presently stops. 3. And, lastly, when the magnet is removed, the iron suspended by it presently falls down; but the moon cannot by us be removed from the sea, nor the earth from a ponderous body in falling; and, therefore, no experiment can, in this respect, be made on them, though the case be otherwise the same *.

Let the fourteenth motion be the motion of configuration, or situation, whereby bodies seem not to affect coming to, or flying from one another, but a certain position, situation, and configuration, with respect to others. This, indeed, is a very abstruse motion, and little enquired into; and, in some cases, it seems to be without a cause, though we judge it not to be really so.

Thus, if it should be asked why the heavens revolve from east to west, than from west to

* Sir Isaac Newton attempts to shew, by calculation, that the moon, and whole solar system, may be sensibly affected by the attraction of the earth; and conjectures that the effect will become more sensible hereafter, by causing a great disturbance in the celestial motions. See Newton. Princip. Lib. III.

east, or turn upon poles placed near the north and south, or nearer the bear, than near Orion, or any other fixed star, the question would appear wild and surprizing, as being supposed a thing that ought to be received from constant observation and experience. And, it is true, there are in nature certain ultimate resorts, and things without a cause; but this does not seem to be one of them. For we judge it to proceed from a certain harmony and consent of the universe, hitherto unobserved. And if we admit the motion of the earth from west to east, the same question would recur, because the earth also must move upon certain poles; but why should these poles be placed rather where they are, than elsewhere?

So likewise the verticity, or the direction and variation of the magnetic needle, may be referred to this motion of configuration. And there are found in bodies, both natural and artificial, especially such as are consistent, and not fluid, a certain disposition and situation of parts, as it were in the manner of threads and fibres, which arrangements should be diligently sought after; for without a discovery thereof, such bodies cannot be commodiously treated, managed, or wrought*.

* Thus, for example, the diamond is flaky or leafy, and has a grain, or a perpetual situation of plates, so as in this

Let the fifteenth motion be the motion of transition, or motion of passage, whereby the virtues of bodies are more or less hindered, or promoted, on account of their mediums, according to the nature of the body, and the virtue of the medium; for one medium suits best with light, another with sound, another with heat and cold, another with magnetic virtues, &c. respectively.

Let the sixteenth motion be what we call by the name of regal, or political motion, whereby the parts predominating and ruling in any body, curb, subdue, and regulate the other parts, and compel them to unite, separate, fix, move, and range themselves, not according to their own appetites, but as it is condusive to the well being of that over-ruling part, so as to make a kind of political government, exercised by the ruling part over the parts in subjection to it.

This motion principally reigns in the spirits of animals, and regulates and tempers all the motions of the other parts, so long as itself remains in vigor. It is also found, in a less degree, in other bodies, as was said above of blood and

---

respect to resemble talc, &c. Wood has its grain, or longitudinal direction of fibres, &c. And the knowledge of those properties in bodies, directs the ways of treating or managing them, as we see in the cutting and polishing of diamonds, the splitting and planing of wood, &c.

urine, which do not resolve till the spirit that mixed and held their parts together is evaporated or stifled. Nor is this motion peculiar to spirits, though these govern or preside in most bodies, by reason of their velocity and penetration; but in bodies more condensed, and not full of a vivid, brisk spirit, (such as is found in quicksilver and vitriol) the gross parts rather have the ascendant, so that unless this yoke, or obstacle, could by some means be shook off or removed, there are no hopes of any new transformations to be wrought in such bodies.

Let no one here imagine, that we forget our immediate business, and (whereas this arrangement and distribution of motions regards nothing more than the better enquiring into and discovering their predominancy by the instances of reluctance*) here treat of this predominancy among the motions themselves; for in the description of this regal motion, we do not treat of the predominancy of motions or virtues, but of the predominancy of the parts in bodies, this being that predominancy which constitutes the peculiar species of motion at present under consideration.

Let the seventeenth motion be the spontaneous motion of rotation, whereby bodies in mo-

* See above, *Aph*, 48.

tion, and favourably situated, enjoy their own nature, follow themselves, and no other thing; but run, as it were, into their own embraces. For bodies seem either to move without any certain end, or perfectly to rest, or else be carried to a period where they may either revolve or rest, according to their nature. But the bodies that are favourably situated, if they move at all, move in a circle; that is, with an eternal and infinite motion. The bodies that are well situated, and yet abhor motion, are perfectly at rest. but such as are not well situated, move in a strait line; that is, in the shortest way, to the association of bodies of their own nature.

This motion of rotation has nine differences, regarding, 1. the centre about which the motion is performed; 2. the poles, with regard to which they move; 3. the circumference, in respect to its distance from the centre; 4. the degree of velocity; 5. the consecution or order of the motion, as whether from east to west, or west to east, &c. 6. the declination from a perfect circle, by spirals, farther off, or nearer to the centre*; 7. the declination from a perfect circle, by spirals, farther from or nearer to the poles; 8. a greater or less distance of the spirals from one another: 9. and lastly, the variation of the

* Viz. Their elliptical motion.

poles themselves, if moveable; which particulars belong not to rotation, unless it be circular.

And this motion, according to common and more settled opinion, is held to be the proper motion of the heavenly bodies. But there is a great controversy, with regard to this motion, between certain of the ancients, as well as the moderns, who, some of them, attribute rotation to the earth. But, perhaps, it were a more proper subject of controversy, (if the thing be not already past dispute) whether this motion, supposing the immobility of the earth, be limited or contained within the bounds of the heavens; or rather descends, and becomes communicated to the air and waters. But for the rotatory motion of projectiles, we refer it to the motion of liberty.

Let the eighteenth motion be the motion of trepidation, whereto, as it is understood by astronomers, we give no great credit. But we meet with this motion upon seriously searching into the appetites of natural bodies, and it seems proper to constitute it a species by itself. This motion is, as it were, a motion of eternal captivity, for when bodies are not perfectly well placed, or situated, according to their natures, and yet are not in a perfectly bad state, they perpetually tremble, and prove restless, neither content with

their present situation, nor daring to proceed farther.

This motion is found in the hearts and pulses of animals, and must necessarily reside in all bodies that remain in a doubtful state, between convenience and inconvenience, so as that when stretched or drawn, they try to free themselves, at which time they again suffer a repulsion, and yet are constantly trying.

Let the nineteenth and last motion be that which, though it scarce answers to the name of a motion, is yet clearly of that kind, viz. the motion of indolence, or, as we may otherwise call it, the motion of dreading or resisting of motion.

By this motion it is that the earth stands firm in its own bulk, whilst the extremities thereof move themselves towards the middle, not to an imaginary centre, but to union. By this appetite, likewise, all bodies violently condensed have an aversion to motion, their sole appetite being not to move; and although they should be instigated and incited to motion infinite ways, yet they obstinately preserve their own nature as far as possibly they can. But if they are compelled to move, they still constantly endeavour to regain rest, and recover their former state, so as, if possible, to move no more. And, in this case indeed, they become agile and swift; and,

as if impatient of all delay, strive with velocity and rapidity to replace themselves. But we have only a partial image, or imperfect notion, of this appetite, because here with us no tangible bodies are condensed to the utmost, on account of the influence and agency of the celestial bodies upon them; and besides they also have some mixture of spirits.

And thus we have proposed the species, or simple elements of motions, appetites, and active virtues, which are most universal in nature, and under which much natural knowledge is contained. We deny not that other species may perhaps be added, that these divisions may be better adjusted to the true divisions or ramifications of things, and that they may be contracted in number. But we mean not this of any abstract divisions, as if any one should say, that bodies desired either the conservation, exaltation, propagation, or fruition of their own natures, or that the motion of things tends to the conservation and good, either of the universe, as the motions of resistance and connection, or of the larger universalities, as the motion of the greater congregation, rotation, and indolence, or of particular forms, as in all the rest; for though this were true, yet it would be speculative, and of little use, unless it terminated in matter and struc-

ture, according to the true divisions or lines of nature.

In the mean time they will suffice, and be of good service in examining the predominancies of virtue, and searching out the instances of reluctance, which is the present business. For of the motions here laid down, some are absolutely unconquerable, some are more prevailing than others, so as to bind, check, and dispose those others, some dart themselves further out than others, some again excel others in point of time and velocity, and lastly, some cherish, strengthen, enlarge, and accelerate others.

The motion of resistance is adamantine and invincible, but whether the motion of connection be invincible or no, is a question; for we determine neither for nor against a vacuum, whether interspersed or collective, only conceive it plain, that the reason why a vacuum was introduced, by Leucippus and Democritus, (viz. because without it the same bodies could not possess and fill a greater or lesser space) is ill founded, because matter may wrap and unwrap itself in space, within certain limits, without the interposition of vacuity. Nor has air two thousand times more vacuity than gold, as on that supposition it ought to have. And this appears sufficiently from the extremely powerful virtues of

pneumatical bodies, (which must otherwise float like fine dust *in vacuo*) and from many other proofs*.

But the other motions govern and obey each other, according to their proportions of strength, quantity, velocity, sphere of activity, and also according to the aids and impediments they meet with. For example, there are armed loadstones that will attract, and suspend, sixty times their own weight of iron, so much does the motion of the lesser congregation prevail over the motion of the larger; but this motion yields if the weight be greater. Leather extends to a certain degree, without breaking, and so far the motion of continuity over-rules the motion of tension; but if the tension be carried further, the leather breaks, and the motion of continuation gives way. Water runs out at a crack of a certain size, in which case, the motion of the greater congregation prevails over the motion of continuity; but if the crack be smaller, the motion of the greater congregation gives way, and that of continuity prevails. If a musquet be charged with sulphur, it will not throw out the ball, in which case, the motion of the greater congregation overcomes the motion of dilata-

* See the Author's History of Condensation and Rarifaction.

tion; but when the musquet is charged with gunpowder, the motion of dilatation in the sulphur prevails, by the assistance of the motion of dilatation, and of the motion wherewith nitre flies from flame. And the like is to be understood of the other cases. For the instances of reluctance, which indicate the predominancy of virtues, and the proportions wherein they conquer and yield, are on all sides to be sought out with great diligence.

So likewise the manner and proportions wherein motions give way, are to be carefully examined, as whether they yield entirely, or rather resist to a degree, but are subdued; for in the bodies among us there is no such thing as true and perfect rest, neither in the wholes, nor in the parts, but only to appearance. And this apparent rest either proceeds from an equilibrium, or an absolute predominancy of motions; by an equilibrium, as in the balance, which rests on both sides, when the weights are equal; by predominancy, as in siphons, or perforated watering-pots, where the water rests, and is kept from falling through, by the prevalency of the motion of connection.

But as we said above, it must be observed, how far these yielding motions resist; for if any person should be forcibly bound hand and foot, or otherwise detained, notwithstanding all the

struggle he could make, his resistance is not the less because it does not prevail. And the state of this matter, (viz. whether the yielding motion be, as it were, annihilated by the predominancy, or whether the resistance be continued, though latent, in the conflict) may perhaps appear from concurrency. For example, let trial be made in shooting, whether a musquet, or cannon, fired at its utmost random, or point blank distance, throws a bullet more forcibly upwards, where the percussion is simple, or downwards where the motion of gravity concurs, or conspires with the stroke.

Lastly, the canons, or rule of the predominancies, which occur, should be collected, as for example, that the more common the good which is desired, the stronger the motion; and that the motion of connection, which regards the communion of the universe, is stronger than the motion of gravity, which regards the communion of dense bodies; again, that the appetites of a private good do not generally prevail against the appetites of a more public good, unless in small quantities. And it were to be wished this also obtained in civil affairs*

* Here is an opening in that kind of Persian magic, which the Author has prosecuted farther on another occasion. Let the several kinds of motion, above laid down, be

49. Among prerogative instances, we assign the twenty-fifth place to intimating instances; that is, such as hint, or point out, the advantages or conveniencies of mankind, for bare power and knowledge only enlarge, but do not enrich human nature, and therefore such things as principally appertain to the uses of life, are to be selected, or culled out from the general mass of things. The more proper place for speaking of these, will be when we treat of reducing knowledge to practice*. But through the whole business of interpretation, we constantly, in every particular enquiry, or upon every subject, allot a place for the table of human uses, or the table of desiderata, wishes, or optatives†; for it is a part of knowledge to enquire, and even to wish discreetly.

50. In the twenty-sixth place, among prerogative instances, come sovereign or general instances; that is, such as regard a variety of particulars, and occur frequently; whence they greatly save trouble, and prevent the search after new demonstrations. But for the instruments

---

compared with those of Sir Isaac Newton, and the modern mathematical writers.

* A part not gone upon in the Novum Organum. See above, *Aph.* 21.

† See the close of the History of Winds, and Condensation and Rarifaction.

themselves, and the particular managements, the more proper place to treat of them is, when we come to the ways of practice, and the method of experimenting*; for the things hitherto known and used, in the exercise of all particular arts, must be described. But at present we will subjoin a few generals with regard thereto, in the way of exemplifying these sovereign instances.

Man, therefore, (besides the business of simply putting bodies together, and taking them asunder) operates upon natural bodies seven principal ways, viz. 1. by excluding such things as might hinder or disturb the process; 2. by compressing, extending, agitating, and the like; 3. by heat or cold; 4. by continuing the matters in a convenient place; 5. by the moderating and governing of motion; 6. by particular consents; 7. by a seasonable and due change, alteration, or series and succession, of all the preceding ways, or at least some of them.

With regard to the first means of practice, viz. by excluding such things as might hinder or disturb the process, the common air, which is every where at hand, insinuating itself, and the rays of the celestial bodies, cause great disturbance; and therefore such things as exclude

* See the *Sylva Sylvarum* throughout. See also the *De Augment. Scientiarum*, Sect. 12.

them, may deservedly be accounted sovereign. And to this belong the matter and strength, or thickness of the vessels, wherein the subject, or bodies prepared for the operation, are included, as also the exact methods of closing up these vessels, with proper and strong materials, or with philosophical luting, as the chemists call it. So likewise the closing of vessels, by means of liquors applied on the outside, is a very useful thing, as when they pour oil upon wine, or other vegetable juices, for the oil floating on the top, like a stopple, excellently preserves them from the injury of the air. Nor are powders unfit for this purpose, which though they contain a mixture of air, yet expel and prevent the force of the external air, as we see in the preserving of grapes and other fruits, by sand or flour. So again, wax, honey, pitch, and the like tenacious bodies, are properly used with a view to close vessels perfectly, and exclude the external air, or atmosphere. And we have sometimes buried vessels and other bodies in quicksilver, the densest fluid that can be employed for this purpose.

Pits, caves, and subterraneous receptacles, are likewise of great use, to exclude the sun; and the open air, which preys upon things. And these kinds of caves are used, in the northern part of Germany, for granaries. And to this head belongs also the suffering of bodies to lie at

the bottom of water. Thus I remember to have heard, that certain bottles of wine, let down to cool in a well, being by a casual neglect left there and forgotten, for many years, but at length drawn up again, the wine was found to be grown, not vapid or flat, but much more generous and noble *. But if it should be required to sink bodies to the bottom of a river, or the sea, without their touching the water, or without being included in stopped vessels, and yet be surrounded by air, the diving-bell, which is a vessel sometimes employed in working upon wrecks, or ships under water, may here prove of good service.

This vessel is made of metal, hollow like a cask, and being let down with its bottom parallel to the surface of the water, it carries along with it all the air it contains to the bottom of the sea †; and having three feet to stand upon, somewhat short of the height of a man, the diver, when he wants to breathe, conveys his head into the cavity of the vessel, where being refreshed with air, he afterwards continues his work. And we have heard, that a boat, or small ship, was lately contrived, wherein men may row under

---

* See the article Maturation, in the *Sylva Sylvarum*.

† See Dr. Halley's account of the diving-bell, in the Philosophical Transactions, No. 349.

water, for some distance*. However this be, under such a vessel as we just now described, bodies may be easily suspended in air, at the bottom of the sea.

There is also another use of carefully including, and shutting up, bodies in vessels, viz. not only to keep out the external air, but also to keep in the spirit of the body, operated upon internally; for it is necessary the operator upon natural bodies should be certain of his quantities, or that nothing should expire or go off; for it is then that deep or great alterations are made in bodies, when as nature prohibits annihilation, art also prevents loss, or the escape of any part of the subject.

But a false notion has here prevailed, which, if it were true, the preservation of the entire quantity of a body, without diminution, might be in a manner despaired of. The notion is this, that the spirits of bodies, and air highly ra-

* An invention of this kind is usually attributed to Cornelius Drebbel, who is said to have had a volatile liquor for restoring the air to its pristine temper, after having been spoiled by respiration. It is farther said, that this effect was produced barely by unstopping the glass, wherein the liquor was contained. But of this matter there seems to be nothing known with certainty, or at best not with the requisite particularity.

rified by heat, can be contained by no vessels, but constantly escapes through their pores. Men have been persuaded to this opinion by those common experiments, 1. of inverting a glass, with a piece of lighted paper, or candle in it, into water, whence the water rises upwards; and, 2. of cupping-glasses, which being heated with flame, attract the flesh. For men have imagined, in both cases, that the air is attenuated, discharged, and lessened in quantity, whence the water, or flesh, succeeds by the motion of connection.

But this is erroneous, for the air is not here lessened in quantity, but contracted in space; nor does the water rise before the flame is extinguished, or the air grown cold, insomuch that physicians, to make the cupping-glasses draw the better, clap sponges upon them, dipt in cold water*. Therefore men need not be so apprehensive that air or spirits should easily escape this way; for though it be true that the most solid bodies have their pores, yet air or spirit will not easily be subtilized to such a degree, as neither will water pass through a very small crack.

* The later manner of explaining this phænomenon by the rarifaction of the internal air, and the pressure of the external, will not here alter the case, because the air, upon this supposition, does not pass through the glass.

As to the second means of practice; viz. by compressing, extending, agitating, &c. it is principally to be observed, that compressions and such kinds of violence, are of very great force in local motions, and the like; as in machines and projectiles; even so as to destroy organical bodies, and their virtues or powers, which plainly consist in motion: for as all life, all flame and ignition, are destroyed by compression; so is every machine spoiled, and its parts confounded, or destroyed, by the same. They are also of force to destroy the virtues consisting in arrangement, or position, and a somewhat grosser dissimilarity of parts; as in colours: for the colour of a flower, when whole, differs from its colour, when bruised; and so the colour of amber when whole, differs from the colour of amber, when bruised. So again, with regard to taste; the taste of an unripe fruit is not the same as when ripe, or after having been squeezed and pressed; but manifestly sweeter. These violences, however, have no great power over the more noble transformations, and alterations of similar bodies; because bodies, by their means do not acquire any new, permanent, and quiescent state; but one that is transitory, and always endeavouring to restore and free itself.

But it might be proper to make some careful experiments to shew, whether the condensation

of a similar body, as water, oil, &c.* or a rarifaction violently introduced, may become constant and fixed, so as to change, as it were, the nature of the subject; and it should first be tried by bare continuance, and afterwards by helps and consents. This would be easier to do in the experiment formerly mentioned for attempting the condensation of water, included in a lead vessel, and wrought by the hammer and the press†; in which case the metalline globe, when beat flat, should be left in that state for some days before the water was taken out, in order to see whether it would immediately fill the same dimensions it had before the operation; for if it did not, either immediately, or soon after, the condensation might seem to have been permanent; or otherwise, if the water restored itself, the compression would appear to have been only transitory.

And something of the same kind might be tried, as to the extension and rarifaction of the air, in glass-eggs, after the manner formerly mentioned‡; when the air being strongly extracted by suction out of the glasses, and the orifices

---

* See an experiment of this kind performed upon air, in Mr. Hauksbee's Physico-Mechanical Experiments, p. 162—166.

† See above, *Aph.* 45. ‡ See above, *Aph.* 45.

suddenly closed and well secured, the glasses are to remain thus for some days; and afterwards to be opened, to see whether the external air would be attracted with a hissing noise in at the orifices of the glasses; or, if being opened under water, the same quantity of water would be drawn in, as if they had been directly plunged into water at first, after the air was sucked out.

It is probable (or at least deserves to be proved) that such condensations and rarifactions may be made; because continuance of time has the like effect in bodies a little more dissimilar; thus, for example, a stick being bent by compression, for some time, does not come strait again. And this cannot be attributed to any loss in the quantity of the wood by the continuance, because the same thing happens also in a plate of iron, which is not exhalable. But though the experiment should not succeed by bare continuance, still the business is not to be deserted, but other assistances used*; for it is no small acquisition, if fixed and constant natures may be given to bodies by violence; for thus air might be converted into water by condensation, and many things of the like kind be performable; for man has a greater command

* Such as large and strong condensing vessels and syringes, for compressing and confining the air.

over violent motions, than he has over the rest*.

The third means of practice regards that grand engine, or instrument, both of nature and art, viz. heat and cold. And here the human power seems perfectly lame on one side; for we have the heat of fire infinitely stronger, or more intense, than that of the sun, as it naturally comes to us, or than the heat of animals; but cold is wanting, unless so far as it may be procured by the severity of winter, by caverns, or by the application of snow and ice, which in the way of comparison may about equal the degree of heat, afforded by the noon-day sun in some parts of the torrid zone, increased by the reverberations of mountains and walls; for such a degree of heat and cold may, for a small time, be endured by animals; but this is nothing to the heat of a melting furnace, or to a degree of cold that answers to such a degree of heat. And therefore all things with us tend but to rarifaction, desiccation, and consumption, and scarce any to condensation and inteneration or sup-

* The experiments of this kind seem to have been no way duly prosecuted. The success which Mr. Hauksbee met with, in a slight attempt to destroy the spring of common air, might very well encourage the use of greater violence, stronger vessels, and a greater length of time, for the purpose. See his Physico-Mechanical Experiments, p. 182, &c.

pleness, unless by mixture and, as it were, by spurious means. Wherefore instances of cold are with great diligence to be sought after, such as may perhaps be found by exposing bodies at great heights, in sharp frosts; laying them in subterraneal caves; surrounding them with snow and ice in deep places, or reservatories made for the purpose; by letting bodies down into wells; burying them in quicksilver and metals; plunging them in the waters which petrify wood*; burying them in the ground (as they relate of the matter for making porcelain) and the like. So likewise the condensations naturally made by cold are to be sought, that their causes being discovered, such condensations may be transferred into arts. Such natural condensations we see in the sweating of marble and stone; in the dew condensed on the inside of glass windows after a frosty night; in the condensation of vapours into water within the earth, whence springs frequently arise; and other examples of this kind.

But beside those things which are cold to the touch, there are certain others potentially cold, which also condense, though they seem to ope-

* For producing the greatest degree of artificial cold, by freezing mixtures, see Mr. Boyle's History of Cold; and the chapter of fire, in Dr. Boerhaave's Chemistry.

rate only upon animal bodies, and scarce upon others. And of this kind are many things in medicine; for some remedies condense the flesh and tangible parts, such as astringents and thickners; and others condense the spirits, as appears chiefly in narcotics *.

There are two ways of condensing the spirits by soporiferous medicines; the one by appeasing the motion of the spirits; and the other by dispelling or putting them to flight. Thus violets, roses, lettuces, and the like mild and gentle things, by their friendly and moderately cooling vapours, invite spirits to unite and restrain their brisk and restless motion; but the stronger opiates, by a malignant and unfriendly quality, put the spirits to flight; and therefore, if these are applied externally, the spirits presently retire from the part, and willingly enter into it no longer; but if taken internally, their fumes ascending to the head, every way chase away the spirits contained in the ventricles of the brain; and when the spirits thus retreat, and are unable to fly into any other part, they consequently come together, and are thus condensed, or sometimes quite extinguished or suffocated; though the same opiates taken in moderation, have the virtue by a secondary accident, (or by that con-

* See the History of Life and Death.

densation, which succeeds upon the coming together of the spirits) of supporting and fortifying the spirits, and checking their useless and incentive motions; whence such opiates become of good service in the cure of diseases, and the prolonging of life *.

The preparations of bodies, likewise, for the admission or reception of cold, cannot be omitted. Thus it is thought that a little warming of water, hastens its freezing by cold, more than if the water was not warmed at all. And the instances of this kind are to be collected †.

But as nature supplies cold so sparingly, we should here imitate the apothecaries (who, when a simple cannot be procured, substitute one thing for another) and carefully search out the substitutes or succedaneums for cold; that is, we should enquire how condensations may be made in bodies, without cold, whose proper office it is to effect them.

And these condensations seem to be of four kinds; the first whereof depends the bare contrusion, which because of the resistance, or recoiling of bodies, has but little force in causing a permanent density, though it may do somewhat as an auxiliary. The second is made by

* See the History of Life and Death.

† See Mr. Boyle's History of Cold.

the contraction of the grosser parts of a body after the avolation or exit of the finer, as happens in indurations by the fire, and the repeated quenching of metals, &c. The third is made by the approach or coming together of the more solid, or poderous, homogeneous parts of a body, which before were separated and mixed among the less solid; as in recovering the quicksilver from mercury-sublimate, which in powder possesses much more space than simple mercury; and so again, in purging and separating of metals from their dross. The fourth is made by consent, or applying such things as condense by a secret virtue in bodies, though these consents have hitherto seldom appeared, which is no wonder, because till some progress is made in the discovery of the forms and structures of things there can be but slender hopes of advantage arising from the enquiry into the consents of bodies *.

But with regard to the bodies of animals, there are doubtless many remedies, both internal and external, which condense, as it were, by consent, according to what was just now observed; but this kind of operation is rare in inanimate bodies †. There goes a report, as well in writ-

* Because such consents, or particular agreements, depend thereon.

† See the History of Condensation and Rarifaction.

ing as discourse, of a tree in one of the Tercera Islands, that perpetually distils water, so as to be of some convenience to the inhabitants *: and Paracelsus says, there is a plant called Rosa Solis, or Ross Solis, that remains full of dew in the noon-day heat, when all other herbs are dry †. And if these instances are true, they might prove of noble use, and very worthy of farther examination. But for those honey-dews, which, like manna, are found upon oak-leaves in the month of May; we judge they are not made or condensed by any consent or peculiarity in the oak-leaf, but that they fall upon other leaves also, and are only catched and detained upon the leaves of the oak, because these are closer, and not so spongy as most other leaves.

As to heat, men have a large supply, and a great command thereof, though some of its most necessary particulars still remain to be observed, and enquired into, notwithstanding the boasts of the chemists. For though the works of intense heat are much sought after and admired, yet the effects of a slow heat (which are chiefly those produced by nature) remain unexperienced and concealed. Hence we see by the violent heats

* See Dr. Sprat's History of the Royal Society.

† See the *Sylva Sylvarum*.

now commonly used, the spirits of bodies are greatly exalted, as in mineral acid spirits, and certain chemical oils, but the tangible parts are hardened, and sometimes fixed, with the loss of the volatile ones. And thus the homogeneous parts are separated, and the heterogeneous grossly incorporated and mixed together, whilst the structure and more subtile texture of compound bodies, is, by this means, confounded and destroyed, so that the effects of a milder heat ought, by all means, to be tried and discovered; whence much more subtile mixtures and regular textures, or structures of bodies, might be procured in imitation of nature and the works of the sun, according to what we intimated above*. For the operations of nature are performed by much slower degrees, or much smaller steps and portions at a time, and by more exquisite and various positions or arrangements, than the works of fire, as it is now employed. And it is then that the human power may seem truly enlarged, when, by heats and artificial ways, the works of nature may be exactly imitated, or expressed in appearance, perfected in virtue, and varied in number; to which we may also add, accelerated in time†. Thus the rust of iron is a long while in making, but expeditiously ob-

*See *Aph.* 35. † See the *Sylva Sylvarum.*

tained in the artificial Crocus Martis. And the same is to be understood of verdigrease and ceruse. Crystal is produced by a long process, but glass by a short one; stones grow slow, but bricks are presently made.

And all the diversities of heat, with their different effects, are, with diligence and industry, to be sought out and collected from all quarters, viz. (1.) those of the heavenly bodies, by their direct rays; and as they are reflected, refracted, and united by burning-glasses*: (2.) those of lightning, flame, and coal-fires: (3.) Fires of different material: (4.) open fires, close fires, straitened and streaming fires; or fires modified by all the various structures of furnaces: (5.) Fire animated by the blast: (6.) Fire left to itself, unexcited: (7.) Fire removed to a greater or less distance: (8.) Fire acting through different mediums: (9.) moist heats, as those of the Balneum Mariæ, and the dunghill; external and internal animal heats; compressed hay, &c. (10.) dry heats; as of ashes, lime, sand; and, in short, heats of all kinds, with their various degrees †.

---

* See the experiments made with the Duke of Orleans's burning lens, by M. Homberg; *Memoir. de l'Acad. Roy.* An. 1702. See also the Philosophical Transactions, and German Ephemerides, to the same purpose.

† See the New Atlantis, in a collection of the Author's Miscellaneous Writings, printed uniform with the present Work.

Above all, the enquiry and discovery of the effects and productions of heat, continued and remitted gradually, regularly, and periodically, at due distances, and with due continuance, should be attempted; for this stated inequality is a true offspring of the heavens, and the mother of generation. Nor is any thing extremely great and commanding to be expected from a vehement, hasty, and subsultory heat. This appears plainly in vegetables; and again in the wombs of animals, where there is a great inequality of heat, from the motion, the sleep, the food, and the passions of the female in gestation; and, lastly, the same inequality takes place in the matrices of the earth, where metals and minerals are formed.

This renders the unskilfulness of some modern alchemists the more remarkable, who expect to obtain their end by means of an athanor, or the equable heats of lamps, &c. kept burning in one constant manner*. And so much, at present, for the works and effects of heat. Nor is it yet the season to examine these particulars thoroughly, before the forms and textures of bodies shall have been farther discovered and brought to light, for it is then that instruments are to be sought out, applied, and adapted, when the ex-

* See the *Sylva Sylvarum*, under the article Gold.

amples, views, and designs, are fixed and determined.

The fourth means of practice, viz. continuance, is the provider and dispenser of nature. We call that continuance, when a body is left for a considerable time to itself, guarded and defended from all external force, in which state the intestine motions discover, and finish, or perfect their own course, whilst the extraneous and adventitious motions are excluded, for the works of time are much more subtile than the works of fire*. Wine can no way be so well clarified by the fire, as by time, nor are the incinerations made by fire so exquisite as the resolutions, consumptions, and decays of time. The sudden and precipitate incorporations and mixtures made by fire, are far inferior to those made by time. And the different and various textures, which bodies endeavour at by continuance, as in the case of putrefactions, are destroyed by fire, or a violent heat†.

It may be here proper to observe, that the motions of bodies perfectly included, or close confined in vessels, suffer something of violence, as this imprisonment hinders the spontaneous

* See the *Sylva Sylvarum*, under the articles Heat, Preservation, and Putrefaction.

† See the *Sylva Sylvarum*.

motions of the body, and therefore continuance in an open vessel, conduces more to separation; but in a vessel perfectly closed, to commixture, or combination, and in a vessel imperfectly closed, without excluding the air, to putrefaction*; and in all these cases, instances of the works and effects of continuance are to be diligently collected from all quarters.

The fifth means of operating, viz. by government and regulation of motion, is extremely powerful. We call that the government and regulation of motion, when one body, by meeting another, hinders, repels, or directs its spontaneous motion. And this generally consists in the figure and position, or situation of the vessels; thus the figure of an erect cone forwards the condensation of vapours, in alembics, but an inverted cone promotes the purging of sugar, or the discharge of the treacle into the receivers†. Sometimes also curvature, or flexure, straitness, and dilatation, are required by turns, and the like. And all percolation depends upon this, that whilst the opposing body opens to one part of the liquor, it closes upon or stops another‡.

---

* See the article Putrefaction, in the *Sylva Sylvarum*.

† And hence the figures, or make of all the chemical, or other vessels, may be easily determined. See Boerhaave's Chemistry, under the chapter of Vessels.

‡ See the articles Clarification and Percolation, in the *Sylva Sylvarum*.

Nor is the business of percolation, or other regulation of motion, always carried on by external means, but also by internal, or by means of one body within another, as when stones are put into water to collect its sediment, or earthy parts, or when syrups are clarified with the white of eggs, whereto the grosser fæculences adhere, and may be afterwards separated. And to this regulation and direction of motion, Telesius, from a slight and superficial consideration, attributes the figures of animals, as if they were moulded, and took the impression of the veiny, wrinkled, and hollowed sides of the matrix. For he ought to have considered, that though eggs also are formed in the uterus, after the same manner as the fœtus, yet no wrinkles or inequalities appear on their shells. But it is true, indeed, that the regulation of motion produces figure in moulding and cast-work.

The sixth means of practice consists in operating by consents, or avoidances, which frequently lie deep concealed; for those usually called occult, and specific properties, and sympathies and antipathies, are in great measure the corruptions of philosophy. Nor can we have any solid hopes of discovering the consents of things, before the discovery of forms, and simple textures, for consent is no more than the sympathy or correspondence of forms and textures to each other.

But the greater and more universal consents of things, are not absolutely obscure. We will therefore begin with these. The first and principal diversity of things is this, that some bodies differ greatly in their quantity, and rarity of matter, yet agree in texture, whilst others agree in quantity, and rarity of matter, but differ in texture. For it is well observed, that the two chemical principles, sulphur and mercury, run, as it were, through the universe of things*. And, doubtless, there appears to be a certain consent of nature, or an agreement of bodies, in these two principles, from a consideration of the most universal phœnomena. Thus there is an agreement betwixt brimstone, oil, unctuous exhalations, flame, and perhaps the body of the stars; and again, between quicksilver, water, and aqueous vapours, air, and perhaps the pure interstellar æther. But these two larger sets, or tribes of things, differ prodigiously from each other in quantity of matter and density, though they greatly agree in texture, as appears in numerous instances. But, on the other hand, the different metals have a great agreement in quantity of matter and density, especially in respect of vegetables, &c. but differ greatly in texture,

* See the *Sylva Sylvarum*, under the article Principles of Chemistry.

whilst vegetables and animals have an infinite variety of texture, yet differ not considerably in quantity of matter or density*.

The next most general consent is that betwixt primary or perfect bodies, and their fostering matters, that is their solvents and aliments. It must therefore be examined, in what climate, in what earth, or glebe, and at what depth, all the metals are generated†; and so of gems, whether those of the rock, or produced in mines‡; in what glebe, or earth, all trees, shrubs, and plants, principally grow and delight; likewise what amendments, or kinds of composts, whether of chalk, sea-sand, ashes, &c. succeed the best; and which of them are fittest, and most serviceable, according to the difference of the land. So again, the grafting and inoculating of trees and plants, with the methods thereof, for the most successful ingrafting has a great dependance upon consent, betwixt the trees ingrafted. In which respect, it is an agreeable experiment, which we are informed was lately tried, of the ingrafting of field trees, which has hitherto been practised only in those of the garden; whence the leaves and mast of the former have been ob-

* See the History of Condensation and Rarifaction.

† See Becher's Physica Subterranea.

‡ See Mr. Boyle's piece of the Origin and Virtues of gems.

tained much larger, and the trees rendered more shady*. In like manner, the aliments of animals must be respectively noted in general, together with their negatives†; for carnivorous animals cannot be fed with herbage. Whence, (though the will in men has a greater influence over their bodies, than in other animals) the order of the folietani, or leaf-eaters, is said to have dropped, after trial, upon finding that leaves were not capable of nourishing the human body‡. Again the different matters of putrefactions, whence little living creatures are bred, should be likewise regarded §.

The consents betwixt perfect bodies, and their subordinates, as exemplified above, are sufficiently manifest, whereto may be added the consents betwixt the senses and their objects. And as these latter consents are exceeding evident, well observed, and thoroughly discussed, they may afford great light to other consents that are hitherto latent ‖.

---

* See the *Sylva Sylvarum*, under the article Vegetables and Vegetation.

† As in discovering the form of heat. See the Tables, *Aph.* 12, &c.

‡ See the *Sylva Sylvarum*. § Ibid.

‖ See the *Sylva Sylvarum*, under the articles Imagination, Senses, Sound, Sympathy, &c.

But the internal consents and avoidances of bodies, or their affections and disagreements, vulgarly, and often superstitiously, called by the name of sympathies and antipathies (whence we unwillingly use the expression) are exceeding rare, as being either falsely attributed to things, mixed with fables, or overlooked and neglected. Thus there is said to be an enmity between the vine and the colewort, because they thrive not well when planted near each other, whereas the reason is, that both of them are succulent, and powerfully attract the moisture of the earth; whence they mutually defraud each other. So there is said to be a consent, and friendship, betwixt corn and the red poppy, because they both grow only in ploughed ground, whereas there rather seems to be an enmity between them, because the poppy grows from such a juice of the earth, as was left and rejected by the corn, so that the sowing of corn prepares the ground to yield poppies. And there is a great number of these false reasons, and fictitious solutions of consents or sympathies prevailing. But fables are here to be absolutely rejected, whence there will remain but a slender stock of such consents as are approved by certain experience, like those between iron and the loadstone, gold and quicksilver, &c. though there are some others also found worthy of observation in chemical experi-

ments upon metals *. But the most are to be observed in certain medicines, which, by secret and specific properties, regard either certain parts, or humours of the body, or certain diseases, and sometimes individual natures †.

Nor are the consents between the motions and changes of the moon, and the affections and passions of the inferior bodies, to be omitted; so far as they may be observed, and collected, from the experiments of agriculture, navigation, and medicine, or otherwise, with the requisite severity, and justness of choice and judgment ‡. And the less common all the instances of secret consents are, with the greatest diligence they ought to be enquired into, upon the footing of faithful history and just relation; provided this be done without levity, or credulity, and with a proper degree of doubt, suspension, and tradition §.

There is still another consent of bodies, in the way of operating, which, though it seems inartificial, is yet of excellent and various use, and ought therefore to be enquired into by the means of careful observation; viz. a disposi-

* See Becher's *Physica Subterranea*.

† See Mr. Boyle of *Specific Remedies*.

‡ See the *Sylva Sylvarum*, and History of Winds.

§ See *Sylva Sylvarum*, under the articles Imagination, Sympathy, &c.

tion, or indisposition, to unite by simple composition, or apposition: for some bodies easily and readily mix and incorporate; but others with difficulty, and unwillingly. Thus powders mix best with waters; but calxes and ashes with oils, &c. And not only the instances of the propensity or averseness of bodies to mix, are to be collected; but likewise the instances of the arrangement of parts; their distribution and digestion upon mixture; and, lastly, those of predominancy after the union is made*.

The seventh and last method, or means of practice, is to operate by changing, and variously combining the former six. But till each of those shall have been farther enquired into, it will not be seasonal to offer any examples of this method. The series, or chain, of this kind of alternation, or different combination of ways, as it may be accommodated to the production of particular effects, is, indeed, exceeding difficult to be understood; though extremely powerful in the effecting of works. But mankind labour under the utmost impatience, with regard to this

* It deserves to be attentively considered, how ready and commodious a thing practice would prove, if all the assistances here pointed out, were procured; and employed, as they might be, according to the design of this piece.

kind of enquiry and practice *; though it be like a clue to the labyrinth of great works †. And thus much by the way of illustrating sovereign instances.

51. In the twenty-seventh, and last place, among our prerogative instances, come magical instances; by which we understand such wherein the matter, or efficient, is but small, compared with the greatness of the work, or effect, produced: so that though these instances were common, they would still be almost miraculous; some of them at first sight, and others even when attentively considered. Nature, indeed, of herself, affords these sparingly; but what she may do, when farther searched and entered into; and after the discovery of forms, latent processes and concealed structures; will appear to posterity ‡.

---

* That is, they have not patience to go through the enquiry, which alone directly leads up to practice: or they preposterously desire to obtain the end, without enduring the means.

† The reader may have some tolerable notion of the thing here meant, by carefully reading over the author's Histories of Life and Death; of winds, and of Condensation and Rarifaction; and understanding to what discoveries they lead; or what the tendency is of the whole.

‡ Little progress has been hitherto made in this medullary part of physics; for men have frequently mistaken, or

These magical effects, so far as we can hitherto conjecture, are produced three ways; viz. (1.) by self-multiplication, as in fire, and those poisons, called specific; as also in motions, which pass and increase, as they go, from wheel to wheel; (2.) by excitation, or invitation, in another body; as the loadstone animates numberless needles, without loss, or diminution of its virtue: and we find the same kind of virtue in yeast, &c. (3.) by the preoccupation of motion, as we above observed in gunpowder, guns, and mines *.

The two former of these methods require the discovery of consents; and the third, the measure of motions. But whether there be any method of changing bodies in their smallest parts, and transposing the more subtile textures, or structures, of matters (which is a thing that regards all kinds of transformations in bodies; so that art might thus quickly effect, what nature is a long while in bringing about. We have hitherto no certain indications. For as in things that are solid, true and useful, we aspire to the ultimate, or highest perfection; so we perpetu-

wilfully deserted, the road that leads to it; though this was not only pointed out, but entered by the author; as appears remarkably in his *Sylva Sylvarum*; History of Life and Death; History of Winds, &c.

* *Aph*, 36.

ally despise, and to the utmost of our power, discard and reject such as are vain, tumid and empty. And so much for the subject of prerogative instances.

52. It must be observed, that in this our new machine for the understanding, we deliver a logic, not a philosophy: but as our logic directs the understanding, and instructs it, not like the common logic, to catch and lay hold of abstracted notions, as it were by the slender twigs, or tendrels, of the mind; but really enters, and cuts through nature, and discovers the virtues and actions of bodies, together with their laws, as determined in matter; so that this knowledge flows not only from the nature of the mind, but also from the nature of things, and the universe; hence it is no wonder, that in order to give examples and illustrations of our art, we every where employ physical considerations and experiments.

We have here laid down twenty-seven prerogative instances, viz. 1. solitary instances; 2. travelling instances; 3. glaring instances; 4. clandestine instances; 5. constituent instances; 6, conformable instances; 7. singular instances; 8. deviating instances; 9. frontier instances; 10. instances of power; 11. accompanying and hostile instances; 12. subjunctive instances; 13. instances of alliance; 14. crucial instances;

15. instances of divorce; 16. instances of entrance; 17. summoning instances; 18. journeying instances; 19. supplemental instances; 20. lancing instances; 21. instances of the staff; 22. instances of the course; 23. doses of nature; 24. instances of reluctance; 25. intimating instances; 26. sovereign instances; and, 27. magical instances. And in point of information, they assist either the sense, or the understanding: the sense, as the five instances of light; and the understanding, either by hastening the exclusion of the form*, as the solitary instances; or by contracting, and more nearly indicating, the affirmative of the form †; as the travelling, glaring, accompanying, and subjunctive instances; or by raising the understanding, and leading it to kinds, and common natures; and that either immediately, as the clandestine, and the singular instances, and instances of alliance; or in the next degree, as the constituent instances; or in the lowest degree; as the conformable instances; or again, by rectifying the understanding, depraved by the things whereto it is accustomed, as the deviating instances; or by conducting it to the great form, or fabrick of the universe, as the frontier instances; or,

* See the tables, *Aph.* 11, 12, &c.

† See the tables, *Aph.* 11, &c.

lastly, by guarding it against false forms and causes, as the crucial instances, and instances of divorce.

And as to practice they either mark out, measure, or facilitate it. They mark it out by shewing with what particulars we are to begin, to prevent labouring in vain; as the instances of power: or to what we should aspire, if it be attainable: as the intimating instances: the four mathematical ones, measure and limit it; and the sovereign and magical ones, facilitate it *.

* If all this has not been clearly perceived in reading the foregoing Doctrine of Prerogative Instances, the whole may deserve to be read over again, in the light that is here afforded. And as a foundation, let the fourth *Aphorism* of this *Second Part* be well understood. When the whole is conquered, it will appear, that this Doctrine of Instances is a very important part of the Novum Organum, and makes the business of enquiry an almost mechanical thing, level to every capacity; for if the Instances, that is, Particulars, be collected upon any subject, and thrown into Tables, in the manner here directed, they of themselves exhibit a concise history of the subject, that leads up to its Form, or latent process. Hence this Doctrine of Instances is a kind of general Direction, or Table, for the due conducting and prosecuting of all enquiries; so as at the same time to determine, limit, or almost grasp, the form of the nature enquired into, and lead directly to practice. And in this view let the author's particular histories be constantly read; as those of Life and Death; Winds; Condensation and Rarifaction; and several in the Sylva Sylvarum.

And of these twenty-seven instances, a collection of some should be made at first, as was above observed *; without waiting till we come to particular enquiries; and of this kind are the conformable, the singular, the deviating, and the frontier instances; the instances of power, of entrance, intimating, sovereign, and magical instances, because these either assist and rectify the understanding or the sense, or afford instruction with regard to practice in general; and for the rest, they are to be searched out when we make tables of view † for the business of the interpreter, upon any particular subject. For the instances honoured and enobled with these prerogatives, are like a soul among vulgar instances of view; and as we said at the first ‡, a few of them serve instead of many, and therefore when we make tables, such instances are studiously to be sought out, and set down therein. The doctrine of them was also necessary to what we design shall follow; and therefore a preparatory account thereof was here requisite.

And now we should proceed to the helps and rectification of induction, then to concretes, latent processes, concealed structures, &c. as mentioned in order, under the twenty-first apho-

* See *Aph.* 32. † See *Aph.* 11, &c.
‡ See *Aph.* 22.

rism; that at lenth, like faithful guardians, we might possess mankind of their fortunes, and release and free the understanding from its minority, upon which an amendment of the state and condition of mankind, and an enlargement of their power over nature, must necessarily ensue. For by the fall man at once forfeited his innocency, and his dominion over the creatures, though both of them are, in some measure, recoverable, even in this life: the former by religion and faith; and the latter by arts and sciences. For the world was not made absolutely rebellious by the curse, but in virtue of that denunciation, "In the sweat of thy brow thou shalt eat thy bread," it is at length, not by disputes, or indolent magical ceremonies *, but by various real labours, subdued, and brought in some degree to afford the necessaries of life.

* Such as those in the Sympathetic Philosophy; the Magical Philosophy of Paracelsus, &c.

APPENDIX.

CONTAINING

SOME INTIMATIONS FOR PERFECTING THE

Novum Organum.

APPENDIX.

THE author purposely left many parts of his new engine untouched, to go in quest of proper materials whereon to employ it; and, being prevented by death, did not return from prosecuting the latter design, to finish the former. Whence though the parts that are treated, appear perfect, as parts; yet the whole of this grand engine wants much of being compleated.

The contrivance itself has, by the greatest masters in science, been thought the best adapted, and most serviceable, of all those at any time proposed, for the advancement of philosophy and art; so that to perfect and fit it for general use, may deserve more than ordinary care and concern.

And though to bring it so forward as we find it, was the labour of a master-builder; though the work, in its own nature, is difficult, and, to vulgar philosophers, somewhat paradoxical; yet, perhaps, the author has left such instructions concerning it, as may enable workmen of a lower class to finish it, and render the metho-

of using it generally intelligible: which seems rather to require sedulous application, than any extraordinary learning, or uncommon abilities.

In order, therefore, to promote the finishing thereof, it may be proper to indicate the more considerable attempts that have hitherto been made, with a view to something of the kind; and shew what farther remains to be done, with regard to the perfecting of this noble invention, and bringing it into familiar use.

Aristotle has left us four books of analytics: the two first whereof, shew how to construct the forms of reasoning; and the two latter, deliver the art of discovering and judging of things.

These books of analytics appear to have been little understood, till they were illustrated and explained by Gunther; with the addition of what is found to the same purpose in Plato * and Galen †. Gunther has two treatises upon the subject: from whence many latter writers upon methods, seem to have drawn their doctrine; only illustrating it with examples derived from mathematics, algebra, and physics ‡.

---

* See Plato, in Phædr.

† See Galen, de optim. Docend. gen.

‡ See Owenus Guntherus Methodorum Tractatus duo, continentes totius artis Logicæ medullam, facultatem omnium Scientiarum ac Demonstrationum Principia inveniendi, dijudicandique rationem. Helmstad. 1586.

This work of Gunther was many years after succeeded by another of the great mathematician Weigelius; wherein he endeavours to deduce the art of demonstration from mathematical principles; and farther to explain, illustrate, and shew the use of Aristotle's analytics *.

The celebrated M. Des Cartes wrote an express treatise de Methodo; wherein he reduces the whole art to four rules, that seem contained in Aristotle's analytics; and will be found to coincide with the Medicina Mentis, mentioned below. This method of Des Cartes, is delivered, with considerable improvements, in the fourth part of the Art de Penser; where the author constitutes to method; viz. the analytical, and synthetical; the former discovering, and the latter for teaching. And he illustrates the whole with a variety of examples, as well physical as mathematical.

Upon the same foundation, in the year 1687, the excellent M. Tschirnhaus, a member of the Royal Academy of Sciences at Paris, published an essay towards a genuine logic, or method of discovering unknown truths †. This is an extra-

* See Analysis Aristotelica, ex Euclide restituta. Jenæ. 1658.

† Medicina Mentis, sive Artis Inveniendi Præcepta Generalia: or what explains the design better, Tantamen ge-

ordinary performance, that proceeds entirely upon the mathematical, or rather algebraical method; and deserves to be read with care and attention.

M. Tschirnhaus, reflecting that mathematicians being the only set of men, who either maintained no controversies, or at least soon came to a determination of them; hence apprehended, that mathematicians alone were possessed of the right method of enquiry. Upon this, he applied himself to mathematical studies; in order to see whether, by making the proper alterations, the mathematical method could not also be accommodated to other subjects.

In particular, he applied himself to algebra; and found that this art performs even more than it promises; and with the highest degree of certainty: when, having acquired a habit of solving the greatest difficulties therein, and examining the secret nature of its method, or manner of procedure; he says, he observed that unknown truths may be discovered, after the same manner, not only in mathematics, but in every other science.

He makes the foundation of human certainty to lie in those things wherein the operation of

---

nuinæ Logicæ, ubi disseritur de Methodo detegendi incognitas Veritates. The second edition is corrected and enlarged by the author.

the understanding is most manifest; or those which may be conceived, without any possibility of a contradiction; as that the whole is greater than a part; that the radii of a circle are equal, &c. whence numerous other truths may be drawn: and, on the other hand, he lays it down for certain, that those things which cannot be conceived, are false.

But here the author cautions us against being deceived by the imagination; for, according to him, many things are perceived by the imagination only; of which things, no distinct notion, or conception, can, by words, be communicated to another; as in the case of pain, light, colour, sound, &c. Hence he recommends two ways of distinguishing between the perceptions of the imagination, and the conceptions of the understanding. The first is, by large and frequent experience, and especially, by the help of mathematics, to acquire a habit of finding the difference betwixt them; and the second, is to consider the equality there is in the human understanding, which all men have equally alike: for what a man truly conceives, he can communicate to another; as we see in mathematical demonstrations, which are equally understood by all men; whereas those things which are perceived by the imagination, as he calls it, are perceived unequally, or more by some, and less

by others. And by justly distinguishing betwixt these two powers, or faculties of the mind, he supposes many great errors may be avoided.

We next proceed to the author's method of discovering new truths; wherein he supposes that any one may continually advance to an indeterminate length, without danger of falling into error. And here he advises us first to procure, with great diligence, a stock of all the possible conceptions with the mind, in the common course of studies and occasions, takes cognizance of. For, from these conceptions, definitions, in his method, are to be immediately formed; then properties to be deduced from these definitions; which properties he calls by the name of axioms: and from the definitions, combined all manner of ways, he discovers secondary truths, or theorems; thus making the whole process algebraical.

He determines it to be in the power of men to form scientifical definitions; and in order to form them justly, advises us to consider the manner wherein the thing to be defined is itself actually formed: or, as he calls it, still in allusion to mathematics, generated; and from this consideration, he directs us to derive the definition. Thus, for example, he defines virtue to be the power which men have of preserving their own nature, according to the laws of just rea-

son; or of procuring to themselves all the real perfections both of body and mind; or, again, the perfection, or melioration of human nature, according to the laws of just reason.

To facilitate this business of forming definitions, he lays down three general rules. The first is, for reducing things, in thought, under their ultimate kinds, or most general conceptions. And these highest mental kinds, or classes, he makes to be three; relating to things imaginary, mathematical, and physical: under which heads all things that exist may be ranged.

The second rule is, when things are thus reduced under their highest kinds, or classes, to observe, either by reason or experience, what things those are which remain continually present in every conception.

The third rule is, that all the formed conceptions be so ordered, as to succeed each other, according to what he calls the number of possibilities, or elements; or according as one thing supposes the existence of another: beginning with the simple cases, and proceeding gradually to the more complex.

The first elements of imaginary things, perceived by the sense, he makes to be fluidity, and solidity; the first of the mathematical, he makes to be points, strait lines, and curves; and the first of the physical, matter, motion,

and rest; without which nothing farther can be conceived. These rules he explains and illustrates by many examples, especially of the mathematical kind: and then proceeds to shew the way of forming axioms from these genuine definitions; which he supposes to be the elements, or first principles of truths. And by considering these definitions, either simply, or comparatively, and in all their elementary relations, he deduces those truths from them, which he calls axioms. And thus, by considering the scientifical definitions of a strait line and a circle, or the relations arising from their generations; a large number of axioms may be deduced. For example, from considering the generation of a circle, by the revolution of a strait line about a fixed point, this axiom arises; viz. that the motion is slower towards the centre, and quicker towards the circumference. And so in other cases.

After the requisite definitions are formed, and compared together, the last thing is to combine, or join them with each other, so as to constitute what the author calls theorems, or new truths. For two or more definitions, or natures, being thus joined together, there may hence arise different natures, or new possibilities, depending upon each other: as we see in compound machines, &c. And this the author again illus-

trates with a great variety of geometrical and physical examples. The whole procedure he declares to be the same that is used by the masters of algebra, for solving such problems, as at first sight might appear unsolvable, by any human genius. For a problem being proposed, the thing is represented to the eye, as if it were already known and discovered; so as clearly to shew what particulars are here joined together; whilst the natures, or definitions, thereof are either already known, or actually exhibited. Then each different nature is separately considered, and expressed by a different equation, in the most simple characters possible. And now these several equations are variously compared, or combined together, till a single equation thence arises, and includes the natures before expressed by different equations; so as clearly to demonstrate how the question proposed may receive a solution.

The author afterwards shews how his method of discovering truth may be eased: and in order thereto, first removes the impediments in the way; among the chief whereof he places falshoods, prejudices, and errors; enquires into their origin; and produces instances thereof, in his three kinds of subjects, viz. imaginary, mathematical, and physical. He accounts those the most subtile and treacherous errors, when

imaginary matters are confounded with real, or physical ones; which he observes to be done even by the most acute philosophers among the moderns, in laying down the principles of nature; and shews how various sects and prejudices have thence arisen, and spread themselves.

These false philosophies, and reigning prejudices, he apprehends may be corrected two ways; viz. first, by exactly distinguishing betwixt the operations of the understanding, and those of the imagination; and, secondly, by assisting the understanding, in the discovery of truth, with the imagination directed by a good method of investigation. And this help is afforded, (1.) by a just adapting of words to things; (2.) by proper characters for different ideas; (3.) by motions, or moving engines, and contrivances, to assist the mind in its operations; and, (4.) by new experiments, which give new conceptions. And by this means he supposes the imagination may be brought to cooperate with the understanding.

The second impediment, he makes to be this; that we do not duly regard, nor attentively consider, the things already known: and the third, that we too much regard the usefulness of knowledge, and discoveries; whereas, he says, we ought to content ourselves with the bare dis-

covery of new truths: otherwise we block up the way to the most useful things of all. For a very small natural power, which in the abstract conception, appears of very little significance, may yet prove infinitely useful in its future applications; as in the case of the magnetic needle, printing, gunpowder, &c. For numberless inventions of this kind may be derived from trivial experiments.

The fourth impediment, he makes to be a natural indisposition in men; whence they are not always fit to go upon the enquiry after truth: and for this indisposition he proposes several remedies. The fifth impediment, is a too long series of investigation; which he endeavours to remove by a proper distribution of the work, and establishing a proper order. And the sixth impediment, he makes to be this; that the affairs of life often prevent our enquiring after truth: which hindrance he proposes to remove, by directing us to follow our own inclination in pursuits.

In the last place, he comes to deliver the method of discovering unknown truths, with respect, (1.) to ourselves, in following our own inclinations; (2.) with respect to those sciences, the knowledge whereof is the most necessary, or most pleasing; and, (3.) with respect to natural philosophy, which, when known is, accord

ing to him, the most delightful of all sciences. For by natural philosophy he understands a knowledge of the universe, demonstrated a priori, in exact mathematical order; and confirmed posteriori, by manifest experiments, sufficient to convince the imagination.

Such is the general plan of the Medicina Mentis: wherein we may observe much sagacity and ingenuity: but perhaps, when closely examined, the work will appear a little too much influenced by the notion, which the author at first espoused, of fitting the direct algebraical method to universal philosophy; and that he has thus endeavoured to found an universal art of investigation upon one, which, though extremely noble and excellent, is yet limited or confined: or that, at best, his method is not sufficiently general, or fitted for universal practice; but rather formed according to the model of man, than the model of nature. It may also, till farther improved, appear to be more mental than practical; and to be better fitted for solving phænomena in the ordinary manner, assigning probable reasons of things, and making all square with the human mind; than to discover, and such actuating causes as shall enable men to subdue and conquer nature by works: in which light, it seems to fall vastly short of the Novum Organum, or Art of Investigating Forms.

But though in this principal view, the Medicina Mentis may not be so useful as the Novum Organum, yet they have a remarkable agreement in numerous other respects; and may be made greatly to assist and promote each other: especially the Medicina Mentis will prove serviceable to the Novum Organum, in the forming of notions; which M. Tschirnhaus terms the forming of definitions. Thus much is certain, that they both deserve to be farther improved, and reduced to practice: for the field of nature is so large, as to require all the engines, and artificial helps, that can any way be procured. And if this method of M. Tschirnhaus shall be brought to perfection, or commodiously fitted for practice; it will then, perhaps, be found to coincide with the Novum Organum, so as to constitute a part of that general engine, from whence, it seems in great measure, to have been derived: for, as the Medicina Mentis is the algebra of men, applied to things; so the Novum Organum may be called the algebra of nature, applied to herself.

Among the later philosophers of our own nation, who have endeavoured to improve, or find out, methods of making new discoveries; the principal seem to be Mr. Boyle, Mr. Locke, Dr. Hooke, and Sir Isaac Newton. Mr. Boyle has given us a particular account of the method

he pursued, in his philosophical enquiries; which plainly appeared to be formed upon the model of the Lord Bacon; and is no other than a loose and imperfect kind of induction, proceeding upon certain tables of enquiry, or general heads of history. For in every regular enquiry, Mr. Boyle first proposed to himself three kinds of orders, ranks or classes, under which he ranged all the particulars relating to the history of his subject; whether it were a body, a quality, an operation, or a process. The first general order, or place, was destined to receive all such titles, or heads of enquiry, as readily occurred upon the first deliberate view, or general survey of the subject; the titles being made sufficiently numerous and comprehensive, and not accommodated to any hypothesis. His titles of the second order were set down, after a careful consideration of the heads of the first; trying the experiments, and making the observations there proposed; and after reading authors, conversing with philosophers, and meditating upon the subject; so as thus to have procured a full information with relation to the whole thereof. This set of titles will, of course, be more exact, more full, and better ranged than the first; whence the materials here contained or indicated, will, with the proper introduction, alterations in method, connections, transitions,

additions, farther directions, &c. begin to form a natural history of the subject; that may be improved, from time to time, or from age to age, till it arrives at perfection. Lastly, where the enquiry was difficult, or large, the author thought proper to form a middle order of titles, interposing betwixt the two former; and this by carefully examining and comparing the several particulars ranged under the titles of the first order: so as thus to discover many new directions, and heads of enquiry; which being afterwards added to the former, may require the whole to be new-moulded; and afford a much more copious and useful set of titles, than the first: all which titles are to be filled up, as experiments or observations are made, or the proper informations obtained. But after all, as many particulars may happen to be omitted, or not be thought of at the proper time, or when they are wanted; and as the history must needs be improvable by after thought, and farther knowledge; the author leaves a place empty, by way of appendix to his titles, for receiving the particulars omitted, that belong to some of the titles; but were forgot or overlooked: and another for particulars to be added; under which such new matter was to be received, as might be procured by farther discoveries and improve-

ments made, after the history should be written, or published *.

Mr. Locke appears to have designed a kind of familiar explanation, and illustration of many aphorisms of the first part of the Novum Organum; in his excellent Essay upon Human Understanding; and again, in his posthumous piece, concerning the Conduct of the Understanding; but he seems no where to have explained the second part of the Novum Organum; or the Art of Investigating Forms. His philosophical writings are now generally known and read; but as they tend to the curing of prejudice, preparing the mind, and fitting it for the discovery of truth, rather than to open any fresh fountains of science, or teach the art of discovery, they need not here be insisted on; especially as they have but little immediate regard to natural philosophy; from whence all the sciences should be derived and supplied. And the same character may be understood proportionably of Father Malbranche's Recherche de la Verité.

Dr. Hooke, who was a great master in the art of invention; as appears by his numerous contrivances and discoveries; pursued much the same method as Mr. Boyle. In his piece for

* See Mr. Boyle's Works, Abridgm. Vol. I. Prelim. Disc. p. 24.

improving natural philosophy, he seems to have proposed to perfect the design of the Lord Bacon's Novum Organum. And it is great pity that a person so well suited to the work, did not proceed farther in it. All he has done towards it, is little more than a familiar repetition of what the Lord Bacon had before laid down under the doctrine of idols; helps for the senses; the doctrine of prerogative instances; and the method of collecting a history of nature: though the Doctor has sometimes added apt illustrations, large explanations, and particular improvements.

Had Dr. Hooke finished the piece, according to the scheme he at first proposed, it would doubtless have familiarized the parts of the Novum Organum, which are already extant; and, perhaps, have supplied the rest: but as it now stands, it is defective in those very parts which are wanting in the Novum Organum. It was indeed a posthumous piece; and, perhaps, purposely neglected by the Doctor towards the close of his life; for fear of divulging his mechanical, or philosophical, algebra, which he seems to have learnt from the Novum Organum, and desired to conceal *

* See the account of his life, prefixed to his posthumous works, p. 4. See also his method of improving na-

Sir Isaac Newton appears to have had a very extraordinary method of making discoveries; but as that great philosopher did not think proper to reveal it, philosophers of an inferior rank can only guess at it, and admire what they do not fully understand. Where the business of investigation depended upon experiments, as particularly in his excellent enquiries about light, he seems first to have imagined, in his mind, how things were, and afterwards contrived his experiments, on purpose to shew whether those things were as he had preconceived them, or not; and according to the information thus obtained, whether from his own experiments and observations, or those of others; he altered and improved his notions, till after various trials, and various amendments, his notions appeared to be just and perfect. And this is a short, or mechanical method of induction.

But besides this kind of mechanical method, Sir Isaac Newton had a mathematical one, afforded him by his dexterity in algebra, and his admirable invention of fluxions, which are not to be understood and applied in philosophy, without great sagacity and caution, for otherwise

---

tural Philosophy, p. 65. and compare the whole of that piece, the Preface to his Micrographia, and his own particular enquiries, with the doctrine of the Novum Organum.

they will be apt to mislead. And here this great author has shewn uncommon address, and found the secret of calculating mathematical or mental forces, powers, and motions, and afterwards applying them to natural bodies and natural things. But the attempt is suitable only to a distinguishing and sublime genius, that can let mathematics constantly rule and preside over physics, without corrupting philosophy, or rendering it fantastical.

At other times this great philosopher observed the stricter laws of induction, collected the necessary facts, observations, and experiments, and by contemplating them in his mind, or reasoning upon them, gave the result, with its consequences, as in the theory of the tides, moon, comets, &c. So that he seems to have used all sorts of methods by turns, or to have formed one to himself, compounded of the mechanical, mathematical, and the usual inductive method. So that if this mixed method also were to be prosecuted, and brought to the greatest perfection whereof it is capable, it may fall under that still more general one of the Novum Organum.

This Novum Organum, we have seen, is divided by its author into two general parts, viz. one that is designed to be preparatory or introductory to the other, which is scientifical or doctrinal, so as clearly to deliver a new way of proceeding

upon all kinds of enquiries, with the greatest advantage to the mind, for acquiring a thorough knowledge of the works of nature, and leading to an unlimited practice for accommodating human life.

The design of the preparatory part is to remove prejudice, procure a fair hearing, and give some tolerable notion of the whole. It may be subdivided into seven lesser parts, or sections, the first whereof endeavours, 1. to awaken the mind, as it were from its lethargy, and make it see that philosophy and the sciences are so far from being perfected; that, 2. men are hitherto unprovided of the true instruments and means of forming the sciences; 3. that, as knowledge and power constantly go hand in hand, men have but little knowledge, because they produce but few considerable effects; 4. that the common ways of reasoning and contemplating, though so much magnified, are but delusory things, and require much rectification and amendment; 5. that the common logic and syllogism, however useful in common affairs, are of no service in philosophy; 6. that our first notions of things are faulty, and require to be corrected, improved, and verified; 7. that the sure way of discovering truth has not hitherto been tried; 8. that men form vain idols to themselves, instead of discovering the truths of nature; 9. that

a more powerful logic than the common, or a kind of engine for the mind, is absolutely required for the service of philosophy; 10. men preposterously delight in a hasty and erroneous way of disputing, judging, and confuting, according to the scanty measure of their own knowledge, and the supposed truth of their own ill-formed notions.

The second section shews the several errors we commit in forming our notions of things, and how detrimental such errors are to the progress of philosophy. It shews that the mind is tinged and infected four several ways; for, 1. men in general have a strange propensity, and obstinate property, of referring all things to themselves, as if nothing existed otherwise than is represented by their immediate senses, or as if there was nothing in nature but what their senses immediately perceive; whereas the other parts of the universe, as the air, æther, &c. and other creatures, are to be regarded in philosophy, as well as man. And here man is shewn, 1. inclined to feign and invent from within himself, instead of searching and discovering; 2. to be extremely liable to prepossession and prejudice, so as with difficulty to remove those false and superstitious notions he has once imbibed, as of astrology, omens, judgments, &c. 3. to be easily moved and led away by those things that affect the ima-

gination, more than the reason; 4. to be fond of launching into infinity, and the highest universals, disdaining the intermediate truths, which in practice are more serviceable; 5. to be drenched in the affections of his body, and thence easily turned aside to pride, vanity, false hopes, &c. 6. it is shewn that the human senses, without farther assistance, are of little use in philosophy, though men attribute such great matters to them; and, 7. that men are fond of abstract notions, and general theories, at the same time neglecting the due enquiry into nature and particulars, which alone can shew them what things are. And these imperfections belong to the species of men, or mankind in general.

(2.) The mind is also infected differently, according to the constitution, complexion, bent, or inclination of each particular person, or according to his education, custom, conversation, studies course of reading, employ, and other accidental matters, whence every man has his own peculiar bias, or, as it were, his own particular glass, tinged to his humour, through which he views every thing. And hence some men doat on mathematics, others on chemistry, others on logic, &c. and accordingly tinge and infect whatever they apply to, with mathematics, chemistry, logic, &c. whereas the true philosopher should not be warped to any particular branch of

science, but remain equally affected to them all, as they may all afford their assistance in promoting philosophy. But in the present state of men and things, some subtile capacities pursue the minute differences of their subject, and make no end of splitting and dividing, as in anatomy, &c. till the mechanical structure, or organization of the parts, is lost; and others, on the contrary, consider only the wholes, without examining the parts. Some fondly admire the ancients, as Aristotle, Plato, &c. and others some favourite modern philosopher. But unless the mind be thoroughly convinced of the folly and absurdity of such a procedure, and be brought, by art and habit, to a quite contrary temper, true philosophy cannot be effectually promoted; for the sciences formed by distempered minds will partake of the distempers, and accordingly appear trifling, gross, partial, half-faced, distorted, fantastical, &c.

(3.) The third way wherein the mind becomes perverted, is by the abuse or improper use of words, for the philosophical words, in all languages, are commonly false or inadequate marks or signs of things, and by no means convey just and perfect notions. So that men are continually imposed upon, even against their wills, by a wrong imposition of words, which are generally coined by the vulgar; or if by philosophers, it is

without taking the requisite pains and care to form notions duly from things, and then give suitable names to those notions. And hence the reasonings, the discourses, and even the writings of men, are often strangely confused, or but seldom perfectly intelligible, and propagate imperfect notions, which men take by consent, without enquiring whether they are just, or how they were formed. But, in order to improve philosophy, it is of great importance to have words suitably adapted, and kept invariably to denote perfect notions, so as to express or convey such notions without delusion or imposition. But no language of this kind can be made, till a set of such notions shall be duly formed from things, which depends upon the use of induction. And as this language, and these notions, are hitherto in great measure wanting, the mind thus remains unprovided of one very great help for the improvement of philosophy.

(4.) The mind is, again, strangely perverted by fabulous theories, and romantic philosophies, which are extremely numerous, and still continue to increase. The third section divides them into three general kinds, viz. sophistical, empirical, and superstitious. Sophistical philosophies are those formed upon common, or hasty observations and experiments, by a subsequent operation of the mind. Thus Aristotle's philosophy

was formed upon common observations, wrought up by his logic, so as to become sophistical and corrupted: for common observations, and obvious experiments, are not of themselves fit to build a serviceable philosophy upon, as they by no means shew all the secret motions of nature, and the laws by which things are governed. Nor is the common logic an engine at all suited to deal with experiments, observations, and nature.

Empirical philosophies are those formed upon only a few experiments, though made with great exactness, as Dr. Gilbert's philosophy is formed upon his magnetical experiments, and the philosophy of the chemists upon a few repeated experiments of the furnace, &c. But to form a general philosophy upon a few experiments, must needs appear a childish attempt, to those who consider the variety and extent of nature, and the treacherous, faulty, or rash propensity of the mind, in reasoning from them.

Superstitious philosophies are those where matters of faith and religion are worked up with those of reason and sense, which makes fantastical philosophies and heretical religions. Thus the philosophy of Pythagoras was clogged with gross superstition, and that of Plato with one more dangerous; and thus, of later date, a variety of theories have been given of the earth, from the first book of Genesis, which has had the

fate to be differently explained, and worked up into opposite systems, according to the different fancies of men, or the prevailing philosophies of the times. And thus it appears, that scarce any one has had thoughts of deriving a pure and perfect philosophy from nature, that should be a true model of the world, without any more mixture of logic, mathematics, chemistry, magnetics, &c. than may be found in nature.

In the next place are shewn some particular ways which the mind has of abusing itself, by forming wrong notions of the things that are seen and considered. Thus upon seeing the changes wrought in bodies by the mechanic arts, in the way of combination and resolution, men are apt to imagine that nature makes use of the same expedients in compounding and separating bodies, whence seem to have sprung the delusory and imperfect notions of the four common elements, as if all bodies were compounded of, and resolved into these; hence those called the chemical principles, &c. And thus from seeing mechanics work with the ruler and compass, seems to have arisen the crude and imperfect notion that nature operates geometrically, &c. But these, and the like notions, being superficial and erroneous, cannot be admitted into philosophy, without corrupting it. The same is to be understood of logical, mathematical, and metaphysical

notions, rashly introduced and mixed with such as are physical.

Again, the mind is apt to run into two contrary extremes, so as either to be very positive and dogmatical, or else extremely loose and sceptical in philosophy. Thus Aristotle determining to cut off all future occasion of doubting, called up questions, and resolved them, to shew that all was now settled and determined. But Pyrrho and his followers doubted of every thing. And in this manner men commonly either stop short too soon, and fancy that enough is known already, or continue fluctuating in uncertainties, or else turn aside to amusement, instead of endeavouring to procure an active and serviceable philosophy. And unless these perverse habits be corrected, no pure philosophy can be obtained.

But instead of endeavouring to correct these ill habits of the mind, men have the talent to confirm and strengthen them, by corrupt and perverted kinds of proofs and demonstrations, which are generally used instead of the true. For logical demonstrations wrest the works of nature, to make them square with the thoughts of men, whereas the thoughts of men ought to be submitted and formed according to the works of nature, so that logical demonstrations, applied to

physical matters, are only the play of words, or at best deceitful and incompatible. For the unassisted senses are incompetent, notions are ill formed from their reports, the principles of the sciences can never be justly inferred from a number of instances produced only on one side; and the present method of arguing from principles, is erroneous and inconclusive.

The best method of demonstration is shewn to be the demonstration by experience, provided we do not rashly endeavour to judge of other things from it, but proceed therein with great circumspection, and rigorous exactness; which method having been little observed, no wonder if true philosophy be but little advanced.

The fourth section proceeds to shew by what signs or marks false theories and philosophies may be discovered, so as to prevent the mind from being imposed upon. And here it is made appear, that the philosophy in vogue over Europe, is principally the superficial, professorial, disputatious, and sophistical philosophy of the Greeks, and chiefly of Aristotle, a philosophy which, however it may have spread, is little more than logical or verbal, that does not convey such directions as may enable us to perform any thing considerable for the advantage and accommodation of life. And again, it is shewn

that the Greeks were masters of little knowledge, especially with regard to the basis and matter of all other knowledge, natural philosophy.

And here the surest sign whereby to judge of any philosophy, is shewn to be by its fruits or usefulness, in supplying the necessities of mankind, and improving the practical arts whereon the accommodations of life principally depend. But the Greek philosophy having yielded none of these fruits, it is to be accounted barren. And the same judgment is to be made of the chemical and magical philosophies, neither of which have enlarged the human power, in any tolerable proportion to their high pretensions. We are not, therefore, to form a judgment of any philosophy from its show and appearance; the greatness of its authors; the antiquity of its origin; the multitude of its admirers; the reputation it has gained among learned men; nor even from general consent itself; but principally from its use, or the tendency it has to improve the mind, enlarge the human powers, and give us a command over nature.

The fifth section is designed to shew the reasons why the philosophers of all ages have fallen into errors, and made so little real improvement in the business of philosophy. These reasons amount to this, (1.) That when a true estimate is made, there has, through the several ages of

the world, been very little time well suited to the cultivation of natural philosophy, which, as must be well remembered is the foundation of all philosophical knowledge, or the true matter whereof the sciences should be formed: (2.) that during the times best suited to the study of natural philosophy, little labour has been bestowed thereon; the men of genius and learning having chiefly applied themselves to morality, civil policy, and religion: (3.) that scarce any single person ever applied himself entirely to the study of natural philosophy, which having been always looked upon as a kind of secondary thing, was only consulted occasionally, and, in a perverted manner, made subservient to physic, mathematics, &c. (4.) That the true end of philosophy has been entirely mistaken, which is to enrich and ennoble human life with useful inventions, new arts, and new powers; whereas philosophers, as they are called, have had views to the raising of sects, aggrandizing their own names, gaining a dominion over men's minds, or some such inferior and pernicious ends. (5.) That wrong ways have been chose for advancing philosophy; and argument used instead of experiment; reasoning and speculation, instead of close observation and genuine induction; and the true method of raising fruitful axioms, and discovering works worthy of mankind, entirely

neglected. (6.) That a few ancient philosophers have been obstinately and perversely admired, or almost adored, as men of supernatural abilities, to the shameful neglect of improving the human power: whereas the ancients, living in the younger days of the world, were in many points of experience and knowledge inferior to the moderns. (7.) That a false imagination, as if men were possessed of many excellent arts and perfect sciences, has fatally hindered the improvement of philosophy; whereas the arts and sciences, at present in use, are, in reality, but few and weak, in comparison of what may be discovered by the light of axioms. (8.) That much craft and a kind of imposture has been generally used, to make the sciences appear more perfect and compleat than they are; whereby many have been deluded. (9.) That much vanity has been shewn by some modern authors, in boasting themselves, and making great promises of delivering extraordinary things for the advantage of mankind; but shamefully failing in the performance, sober men have hence taken a distaste, and too obstinately believed other practicable things, to be of the same stamp. (9.) That men have generally neglected to propose themselves noble and suitable tasks for the improvement of philosophy; and instead thereof, have indolently determined many sober and ra-

tional things to be mere impossibilities, or beyond the reach of art; at the same time greatly over-valuing slender performances. (10.) That religious zeal, bigotry, and superstition, and the school divinity, have, through several ages, been very unfavourable to the improvement of natural philosophy, and checked its progress. (11.) That the common schools, universities, colleges, and societies of learned men, have also generally opposed all new and considerable improvements in knowledge. (12.) That no sufficient rewards have been allowed for inventors and improvers. And, lastly, that sedate and sober men have indulged an untimely despair, or entertained a belief that no farther Improvements can be made in philosophy. So that under all these obstacles and discouragements, it is no wonder if very little true philosophy has appeared in the world.

The sixth section, of the first part of the Novum Organum, tends to raise the mind from the languor it may have been thrown into, by the melancholy prospect of the former section, and sets before us in a native light, what solid reasons there are to expect, that, notwithstanding the obstacles and discouragements above enumerated, a genuine philosophy may be set on foot; and, if men will not remain wanting to themselves, be brought to perfection, and afford

all those fruits and advantages that the human state is capable of affording.

And here the author observes, (1.) that as the art of navigation, has discovered new countries and carries on a correspondence even betwixt the most distant parts of the globe; great opportunities are thus afforded of procuring the necessary informations for enlarging the bounds of knowledge. (2.) That as we may plainly perceive the errors which the ancient philosophers fell into, and the reasons why they failed in promoting the more serviceable sciences; if the errors they committed are carefully avoided, and a different method to be taken, there are grounds to hope for better success in future. (3.) That therefore the art of experimenting and the art of reasoning are to be joined together; or a new art to be formed by a mixture of the two, in order to procure a Sylva, or suitable collection of prepared and well-digested materials for philosophy. (4.) That natural philosophy must be kept pure and uncorrupted with logic, mathematics, and divinity. (5.) That the mind must discharge itself of all prejudice, false notions, phantastical theories, and useless philosophies, and become fit to receive such notions as are just and purely philosophical, without any way corrupting or debasing them. (6.) That a just foundation must be laid for experience, in a

history of nature, collected with the greatest exactness, diligence, fidelity, and judgment; so as to make it extensive, or to measure of the universe, without admitting any thing faulty, foreign, or superfluous. (7.) That, in particular, the more leading and informing experiments are to be carefully sought and procured. (8.) That a true order or just method of experimenting be introduced, so that experiments may not remain casual things, but an art of experimenting be formed. (9.) That no inventions or particular ways of working or combining the materials of philosophy, be trusted to thought and contemplation, but the whole process be exactly wrote down, or described on paper. (10.) That the matters of a pure history of nature be not left in loose particulars but be regularly digested and brought into tables, according to the nature of every subject, that the understanding may work thereon to the best advantage. (11.) That axioms be formed from these tables, so as to point out new experiments, and thence afford still higher axioms leading to greater works. (12.) That these axioms be formed, not in the way of the ancients, by rising, at once, from particulars to the most general conclusions, but by careful steps in a safe and guarded manner, so that the axioms, thus raised, shall not afterwards deceive, but be thoroughly verified, and remain just and

pregnant expressions of the laws and facts of nature and art. (13.) That a new method of induction be employed in raising these axioms, viz. such a method, as is suited at once, to discover and demonstrate arts and sciences; by investigating the real and internal natures of things. On this new method, or art of induction, the author builds his principal hopes of improving philosophy: and to deliver this art was the principal purport of the Novum Organum; the part we are now upon being only introductory thereto. And to give some intimations for perfecting this art, the present Appendix is wrote. (14.) The last foundation of hope, in the way of forsaking past errors, is this, that natural philosophy may be extended, or made to afford matter to the sciences, and they again be brought back to philosophy, so as to make them centre therein, without mutilating or dismembering the sciences, whilst they, together with natural philosophy, constitute one serviceable corps of knowledge.

(15.) The next fountain of hope for the improvement of knowledge, is the prospect which men may have of future discoveries, if they will put themselves into the proper way of enquiry. For since many discoveries have been hit upon unexpectedly, or by accident; as by the instinct of brutes, &c. without going in quest of them,

greater success may be, doubtless, expected from a proper method of enquiry, and the art of experimenting with reason, industry, and sagacity; more especially by the method of induction abovementioned, which is a contrivance for the speedy bringing of new discoveries to light. (16.) Some considerable improvement of philosophy may be also reasonably expected, if the requisite time, expence, and application shall be used in collecting such a history of nature as was mentioned above, which is a thing that has never hitherto appeared, but may be procured, and is no impossible or impracticable scheme. (17.) And, lastly, though we had less encouragement to hope for success than we have, yet a course of trial and experimenting should be undertaken, because there is thus, at least, a chance of improving philosophy, at the expence of a little labour: whereas, to sit down desponding, or resolved against all trial and attempt, seems unworthy of human nature.

The seventh and last section of this preparatory part of the Novum Organum, is calculated to give some tolerable notion, not only of the design of the second part, but also of the whole; that the nature and use of the new method of induction may be better understood. And here the author declares, that he has no view to found a sect in philosophy, or procure

followers; but only to lead men by the hand a little, in order to shew them the way of following nature, and freeing themselves from the necessity of following any philosopher whatever. And in order to prevent all misunderstanding or misconstruction of this his real design, he proceeds to answer the more considerable objections, that might be apt to arise against it, from the prejudices and false notions which men commonly imbibe.

And first because men are naturally impatient, and immediately desire to see the advantages of new undertakings, the author guards his reader against all rash and hasty endeavours after profit and advantage, as what will prove highly pernicious, and tend to prevent the good effects expected. But for those who cannot wait, he leaves them at liberty to use, in their own way, the several helps he has afforded towards the production of considerable works and effects, for he would by no means hinder, but as much as possible promote and expedite the discovery of all advantageous arts and works. But till a tolerable history of nature is procured, he judges that no very considerable progress can be made in what he calls the genuine interpretation of nature, or forming of rich axioms, that shall lead to new arts and capital works. Such a history, therefore, himself proposes to procure.

But he apprehends, that several objections will be made to this history, as that it will contain false facts, erroneous experiments, and disagreeable, subtile, vulgar or abstruse particulars. But all this he shews amounts to little; because (1.) a few errors, and even falshoods, must necessarily happen in the beginning of a history of nature; and will not prove of any very bad consequence (though they should indeed be cautiously guarded against,) for such errors and falshoods, where but few, are easily discovered and corrected, when axioms come to be raised, or the interpretation of nature to be entered upon. (2.) Vulgar things being usually as much unknown, with respect to their causes, as things uncommon; such vulgar things should not be rejected, but received into a history of nature. (3.) Disagreeable or sordid matters, such as corruptions, putrefactions, &c. must be here necessarily considered, no less than others; because they give great light into the operations of nature; and things for this design must not be judged of by the rules of elegancy, but according to utility. And (4.) subtile, speculative matters, are not here received for the sake of subtilty and speculation, but only as they afford information, lead to practice, and assist in the interpretation of nature.

The author apprehends, it will appear strangely

shocking, insolent and monstrous, that he should at one stroke set aside all the ancient philosophies and all the sciences, and go entirely upon a new scheme of building up philosophy from a different foundation. But he judges, that this procedure, when duly considered, will be found more rational, modest, and serviceable, than to have used artful accommodations, and patched up a deceitful system of new and old materials; for as the ancients raised their philosophies upon false notions, or false principles, discovered in an erroneous manner, there was an absolute necessity of beginning the whole work anew. Nor does he think it insolence, if by means of an engine for the mind, or particular helps which the ancients never knew, any one of common abilities, should raise a more serviceable structure of philosophy, than they by means of the naked understanding.

To the objection, that the end of all this labour is wrong fixed, as tending to practice, and the accommodation of life; and not to the abstract contemplation of truth, which is a much nobler thing; it is answered, that the latter is indeed preferable to the former; but that, in the method proposed, both ends are answered at once, the design being here to give a genuine, a native, and just representation of the world, such as it exists, which is not only the most

useful knowledge, but the noblest contemplation; that unites theory and practice together, in their highest degree, and makes them one and the same thing.

To the objection, that perhaps the author's new method is no more than some old one, and therefore not of any extraordinary use; he answers, that the ancients have delivered their method of forming the sciences; which was by flying immediately from a few particulars to general conclusions; a method very different from the method he proposes, by a rigorous and careful induction: that, in particular, his method does not tend to scepticism, but to a scientifical doubting at first, that the greatest certainties may be afterwards discovered; and that this method regards not any one particular art or science, but all arts and all subjects universally.

But the author hopes that no one will suspect his design is to abolish, and utterly destroy the arts and sciences at present in use: especially as he has, in his De Augmentis Scientiarum, taken so much pains to improve, and shew the way of perfecting them: all he aims at, in this respect, being to convince the mind, that the sciences in vogue are of no use for enlarging the bounds of knowledge, and discovering new arts, and practical works: which end, his own method is entirely calculated to promote. And

yet he does not pretend that this method of his is absolutely perfect or unimproveable; but, on the contrary, that it will doubtless improve, as new arts are found, or new discoveries made. And thus he concludes the first, or preparatory part of this work.

The second part, as was before observed, is wholly doctrinal, or scientifical: and goes directly upon delivering the new art of induction, or method of interpreting nature, in order to form an extensive philosophy; or procure an exact copy of the universe, for perfecting the understanding, and leading to an unlimited practice. And here, as the most excellent things are often the most difficult to obtain; the doctrine delivered will appear somewhat abstruse, till the mind becomes a little acquainted with it; after which all the difficulties vanish, and an agreeable prospect is obtained of a sure and practicable way of procuring, in a moderate time, with the proper assistances, such a philosophy as shall highly improve the state of human nature.

The foundation of the thing is laid in finding a method of increasing the human powers and knowledge, to their greatest possible perfection. And this the author shews may be done by discovering what he, in a new and peculiar sense, calls the forms of things; that is, the laws or

powers of nature, by which things physically exist, are generated, or have their effects. And these forms, or laws of nature, he holds to be discoverable by men; and shews how to discover them: in which single point the whole of his new engine centers. There are but two sections finished of this second part: the first whereof lays the foundation of the doctrine of forms, and exemplifies it by a general example, and a set of tables for the purpose: and the second section shews how to shorten enquiries, conducted in this method; by selecting only the more eminent facts and observations, or capital instances, that lead to a full and perfect discovery; without ranging, in an endless manner, through that immense variety of particulars, to be found in nature.

But as it would be a fruitless labour to go upon discovering these forms, without knowing their use, when found; the first section of this second part shews, that the end of philosophy is to increase either the knowledge, or power of man; so as to enable him to understand the ways and procedure of nature; or else to produce such effects as make for his own advantage: and that to discover forms, is at once to acquire both this knowledge, and this power; because by finding the laws of nature, and her ways of producing effects, men will be enabled, so far as

their condition allows, to use the same, as rules of practice; and thus, in some cases, to equal, regulate, subdue, or even excel nature by art. So that upon the discovery of forms depends the perfection of philosophy, or the enlargement of the human knowledge and power.

This business of discovering forms being of such infinite importance, the author endeavours to make it as intelligible as its nature will admit, in the present imperfect state of minds and things; and shews, that in effect, to discover forms, is the same thing as having some extremely intelligent person, ready at hand, to consult upon all occasions concerning the works of nature, the search after forms being like asking of questions; and the discovery of them like the receiving of answers: so that there is no point of theoretical knowledge, no rules, or directions, required in practice, but what may as well be had by the discovery of forms, as if nature herself were to speak, and tell men how she works; and what they must do to imitate, lead, or command her. For to find a form, is to find a nature, that shall be equivalent to the nature sought; so as when present, or absent, to constitute, or abolish, that nature respectively. Or, to make the conception still plainer, the form of a thing is the effective power, or physical act, by which it exists. Thus if the nature

sought were fluidity, or the means of converting charcoal into a fluid mass; and it be found, by a proper course of enquiry, called the Investigation of Forms, that the form, law, or nature of fluidity consists in a certain size, or smallness of parts, joined with a certain motion; this is finding a nature equivalent to, or convertible with, fluidity: whence men are directed to give this smallness of parts to charcoal, along with the particular motion discovered; upon which, the charcoal will put on the nature of fluidity: and accordingly, if charcoal be reduced to powder, and detained in a close vessel in the fire, till its parts are sufficiently agitated, it will have the appearance of a fluid. And this may illustrate, or give some sensible image of the thing under consideration; and shew that both a perfect theory, and a perfect practice, depend upon the discovery of forms.

But as a pernicious custom of leaving experience, and running into abstract speculations, has prevailed; the author judges it much the surest method to begin to raise the sciences from practice; or to let the practical part describe and limit the theoretical, or contemplative. He therefore enquires what are the best practical rules that could be wished for; and finds them afforded by the discovery of forms: so that, on all accounts, the investigation of

forms is the first and principal thing that can be gone upon, in order to improve philosophy, and perfect the sciences; especially as, at the same time, these forms also afford, according to what was before observed, perfect theoretical axioms, as well as the best practical rules, canons, or precepts.

On this footing, the requisites to practice must be first considered; that is, the means of enlarging the human power, and enabling it to introduce all possible changes upon matter; or produce all possible effects. And here the author shews there are two different kinds of canons, or axioms, for producing transmutations, or changes; viz. one with regard to bodies, as they are an assemblage, or combination, of a set of properties; as gold is of a determinate gravity, ductility, &c. and another that depends upon finding the way wherein nature herself proceeds in the generation or production of bodies; as how gold was made in the bowels of the earth, &c. the first kind of axiom shews how things are made by introducing a certain set of simple properties into a mass of matter susceptible thereof; and the second directs the way of proceeding by seminal properties, as it were; or beginning with the rudiments of things, and using the same first matter, and means, that nature herself employs. And where the power

of mankind cannot possibly reach to operate, as in the heavens, &c. yet even there the facts of nature may be sought; and her laws and manner of proceeding discovered. The whole process of finding these axioms, and discovering the causes of things, the author calls by the name of the interpretation of nature.

This interpretation of nature has two parts; the first with regard to the forming of axioms from experience; and the second with regard to the contriving of new experiments from axioms. The first requires proper helps for the mind; or assistances for the sense, the memory, and the reason: and hence, before this interpretation of nature can be exercised to advantage, a just and extensive history of nature and art must be procured; as the first matter out of which axioms are to be framed, forms discovered, and philosophy built.

This history is not to be a rhapsody, or confused collection of all sorts of Matters, thrown together on a heap; but to be carefully digested, and formed into regular tables, or packets of instances, and prepared parcels of history; as the pillars, the rafters, &c. are made ready for a building. And when such a history shall be procured, the understanding is not to work upon it by means of its own simple natural powers; but is to be assisted by the use of ge-

nuine induction; and thus enabled to practise the art of investigating forms.

1. The subject of enquiry being chose; suppose, for example, the form of heat; all the instances wherein heat is found are to be duly collected, and ranged in a particular table; so as to afford a clear view of these instances to the mind. A distinct enumeration must, therefore, be made of all the things that are hot; as the sun's rays, flame, ignited iron, &c. 2. A collection is to be made, and a regular table formed, of those things wherein heat does not reside: but as this might swell the table immoderately; only such things need be mentioned as approach near to the nature of the former, except in the single property of heat, which they are without; such as the rays of the moon, certain corruscations, glow-worms, &c. that afford light, but no heat. And thus the things that are not hot, being placed over against the things that are hot, the mind may distinctly compare the two sorts together. 3. A table must next be formed, to shew the different degrees of heat, that are found in different things; or to exhibit, at one view, all the instances of heat, with regard to more and less: beginning with such things as are not sensibly hot to the touch, and proceeding gradually to the most violent heats, as those of volcanos, the burning concave, &c.

These tables ought to be drawn from the history of nature and art, mentioned above; or borrowed from the natural historian; and laid before the philosopher, or interpreter of nature; whose office it is to practise the art of induction upon them; so as by comparing them together, both in general, and in particular, to find such a nature, law of motion, or action, as being present, exerted, or performed, in any body, or portion of matter whatsoever, the nature of heat, or heat itself, shall of necessity be produced therein; and such as when that law, motion, or action is absent, heat shall be absent; and so come and go with that law, motion or action perpetually; or attend it in any intermediate degree, according to the exact proportion wherein that law, or action is exerted: which is what the author means by the form of heat.

But here, if the mind should of itself directly endeavour, without farther assistance, to discover the forms of things; it would fall upon ill defined notions, imaginations, guesses, probabilities, and imperfect axioms, instead of true and genuine forms: and thus be far from obtaining the end proposed by this new method. The next step, therefore, is to practise the business of exclusion or rejection; viz. to throw away, or separate in the mind, all those things

from the nature of heat, which do not immediately, and of absolute necessity, belong to it: so that a compleat and perfect notion, axiom, or form, that is the pure conception of the true cause, essence, or nature of heat, may remain as a solid and perfect portion of truth behind. And this exclusion also is to be performed in the way of a table, wrote down as the former. Hence, as the sun's rays are found to be hot, the superficial notion that heat is peculiar to terrestrial bodies, must be rejected, &c.

And thus the business of induction is begun; but by no means rectified and finished: for as this exclusion, or rejection, is the throwing out of simple natures, or properties, from the nature of heat; a perfect knowledge of simple natures is previously required, before the induction can be completed. But men have not hitherto acquired perfect notions of simple natures, or the simplest properties of things; such as tenuity, fluidity, texture, &c. In the mean time, because truth will easier arise from error, than from confusion; the understanding may be permitted, by considering the several tables, to make some attempt towards interpreting nature, in the affirmative; or to find out the positive, actual form; though without pretending that it is truly and perfectly discovered, till all the preceding tables shall have been perfected: which,

as was before observed, depends upon a perfect history of nature; and again, upon using a perfect induction; which is an art that has not hitherto been duly prosecuted, and brought to the necessary degree of perfection.

However, to give an idea of the whole manner of procedure in this business of interpreting nature, when all things shall be properly fitted for the purpose; the author here adds a fifth table, to represent what he calls the first vintage, or dawn of doctrine, from the form of heat. And this table sets to view the process of the mind, solely employed, without distraction, or interruption, upon the several preceding tables, in order to investigate, or discover the form of heat. The result of the whole process amounts to this, that heat is an expansive, bridled motion, struggling in the small particles of bodies: which is a summary expression, or axiom, describing the form of heat, so far as could be derived from the imperfect tables, and the imperfect art of induction here employed. And with this idea of the whole, the author concludes the first section of the second part of the Novum Organum.

In the second section, the author proceeds to perfect the art of discovering forms, or to shew the manner of framing an induction that shall conclude as justly in philosophy, as syllogism

does in logic, or demonstration in mathematics. Accordingly, he here directly treats of prerogative instances, or the way of procuring proper collections of such facts, observations, and experiments, as are best fitted to enter the three tables of view, corresponding to the three first, above-mentioned; so that a few of these instances may answer the purpose of many, shorten the business of search and enquiry, and afford a prepared and proper matter for induction, in all kinds of subjects.

And of these instances, he makes twenty-seven different kinds; viz. 1. such as exhibit the nature enquired after, in things that agree with, or differ from others, in respect to that nature only. 2. Instances wherein the nature sought appears in a state of generation, or destruction. 3. Those wherein the nature enquired after stands alone, in a high degree of perfection or predominancy. 4. Such as shew the thing enquired after, in its lowest state, weakest virtue, or first rudiments. 5. Such as exhibit the nature enquired after, in the way of a lesser form. 6. Such as shew a likeness and relation in the concrete, so as to help in uniting nature. 7. Such as shew bodies in the concrete, as it were out of their course, or broken in nature. 8. Errors of nature, things monstrous, extraordinary, or out of the course of nature. 9. Bodies consisting

of two different natures, or double species. 10. The most perfect works of men in every kind. 11. Instances wherein the nature sought is either constantly present, or constantly absent. 12. Instances that shew the limits of nature, or the bounds betwixt existence and non-existence, in all subjects. 13. Such as mix and join natures supposed to be incompatible, or heterogeneous. 14, Such as shew an inviolable conjunction of one nature to another, and the separable alliance of others. 15. Such as shew the separation of natures that frequently meet. 16. Such as assist the actions of the senses; particularly the sight. 17. Such as bring those things to the senses that did not appear before. 18. Such as discover the motions of nature connected, or gradually continued. 19. Such as afford information, where the senses fail. 20. Such as excite the attention, and hint the subtilty of nature. 21. Such as measure the powers, and virtues of things, by space. 22. Such as measure the powers of nature by time. 23. Such as shew in what proportion, quantity of body contributes to quantity of virtue. 24. Such as shew the prevalency or subjection of virtues to one another; under which come all the species of motion, or active powers. 25. Such as point out advantages and conveniences for mankind. 26. Such as regard things of common occurrence,

and therefore save the trouble of new demonstrations; under which come the several ways of practice, or means of operation. And 27. Such instances as shew that a small quantity of matter, or an apparently small efficient, may have a great effect.

This doctrine of prerogative instances is treated with care; and illustrated with a suitable variety of examples, that open the way to enquiries of all kinds, and lead to the improvement of all the parts of philosophy. so as to shew, in a summary view, what is already known, in numerous subjects, and direct a farther prosecution; at the same time that the author is carrying on his own particular design of perfecting the art of induction; and laying down precepts, and giving directions for the execution of the remaining parts of his work. And here ends all that is left us of the Novum Organum.

It is extremely to be regretted that the author did not finish this piece; of which it is evident he had the complete idea, with its almost infinite train of uses. But there being nothing at that time extant, which could, in any tolerable degree, afford the necessary instances for the tables of view; he thought it incumbent upon him to set an example, at least, of the manner of procuring them; as he did in his Sylva Syl-

varum; and afterwards digested and fashioned many of them into particular tables, in his History of Winds, History of Life and Death, &c.

He had proposed to deliver the remaining parts of this Organum under the following heads, viz. 1. the helps of induction; 2. the rectification of induction; 3. the method of varying enquiries; 4. the prerogative natures for enquiry; 5. the limits of enquiry; 6. the reduction of enquiries to practice, 7. the preliminaries to enquiry; and, 8. the ascending and descending scale of axioms*. It might, perhaps, be of some utility briefly to go over these several heads, so as to indicate a little of the manner wherein it may be conjectured, from his other writings, the author proposed to treat them; and, at the same time, refer the reader to those parts of his own, and other works, where farther light and assistance may be procured towards finishing the whole.

(1.) The first thing in order, after the doctrine of prerogative instances, was to lay down the helps of induction, under which it should seem that the author proposed to deliver, 1. the way of procuring a genuine history of nature and art, as the basis or matter of induction†; 2. to

* See Part II. *Aph.* 21.

† See Dr. Hook's Method of Improving Philosophy, p. 18—33. and Mr. Boyle's Works.

explain the manner wherein this matter might occasionally be reduced into regular tables of view, according to the nature of each subject; 3. to shew the order or method wherein the mind is to consider the instances contained in these tables, both separately and comparatively, or collectively, in order to discover the causes of the thing enquired after, and deduce the axioms for directing new experiments; 4. how these tables of view are afterwards to be improved, or made more full or comprehensive, and ranged anew, so as to exhibit all the particulars, in their most natural order, and afford still greater assistance to the mind, in forming more just and perfect conceptions, notions, and axioms; and, 5. the several ways that might be contrived for helping or improving the senses, the memory, and the reason, in order to the forming a more perfect induction *.

(2.) The rectification of induction stands next in order, by which appears to be meant the making a due exclusion, or rejection, of all those simple natures, or properties, that do not essentially contribute in constituting the form of a thing, so that, after such an exclusion is com-

* See Dr. Hook's Method of Improving Philosophy, p. 12—18. 34—42. and M. Tschirnhaus's Medicina Mentis, p. 182—211, &c. 2d edit.

pleatly made, the pure form shall remain behind, unattended with any thing more than is absolutely necessary, or essential to it; that is, a perfect notion of the essence, or constituent cause of the thing, will be obtained, according to what was mentioned above.

The business of rectifying induction will, therefore, require, 1. a previous knowledge of simple natures, or a set of just and philosophical notions; and, 2. the way of contriving and making certain experiments, or trials, for producing certain works, that shall verify and confirm the truth of induction, by shewing that if men operate according to such rules as are afforded by the axioms, or forms discovered by induction, they may produce the works and effects thus pointed out, which are such as could not be otherwise scientifically produced by men.

The way of forming these notions, is by the use of induction itself, and requires an entire extirpation of all false theories, idols, and vain imaginations, that the mind may become perfectly equable, and disposed to receive these genuine notions*, which are not to be made conformable to the sense of man, but in exact agreement to the sense of nature, so as to be scientifi-

* See Dr. Hook's Method of Improving Philosophy, p. 9. and M. Tschirnhaus's Medicina Mentis, p. 72—91.

cal and just expressions of things, as they exist in nature, and not as the mind of itself, from the first information of the sense, is apt to imagine them. And these notions will enable us to make a true induction, as it were, a *priori*.

But the other way of rectifying induction is a *posteriori*, and depends upon this, that when a form, an axiom, or canon is found, or supposed to be found, by using the tables of view, and the method of rejection, the proper experiments are to be contrived for determining whether this form, axiom, or canon, be real, and not imaginary or fictitious. And here the doctrine of prerogative instances is of great service, in indicating the requisite trials, experiments, or works for this purpose. If the expected effect should in no wise follow, the particulars of the tables were either false or incompetent, for the method, when properly pursued, must needs be infallible. If the effect answer but in part, and no error has been committed in the experiment, then the form, axiom, or canon, must be mended, by going over the induction with more exactness, and better helps. If the effect answers to the full, under a due variation of circumstances, and in all trials, a proof will thus be gained of the justness of the procedure, the goodness of the induction, and the validity of the discovery. And

these two, it should seem, were the principal ways which the author proposed for rectifying his induction.

(3.) The next head is the Method of varying Enquiries, by which we are to understand not only the suiting of the manner of enquiry to the nature of the subject occasionally, but also the ways of transposing, enlarging, and improving the parts of an enquiry, both with regard to the matter and method, according as new information and farther light is obtained.

Thus, when the view is to discover axioms or forms, the enquiry must proceed from particulars to generals, or from a variety of apposite instances, disposed in suitable tables, to the axioms they afford, or the form they point out; but when the design is to lay out a work, which itself is a particular thing, we must begin with generals, or the axioms already obtained, and descend, by degrees, to the work required. And, in both these cases, most of the steps that are first taken will remain improvable, as the mind becomes better acquainted with the subject, and the things that relate thereto, till at length the enquiry turns to a perfect scientifical history, where no farther alteration of the method can be made to advantage, nor any thing farther be added, for discovering the form, or directing the

work, which was the original subject of the enquiry*.

(4.) The next general head of the second part of the Novum Organum, is the Prerogative Natures for Enquiry, whereby we are to understand the art of chusing those subjects, a few of which may serve instead of many, as in the doctrine of prerogative instances, where the author has shewn how all infinity of search may be cut off, or how, instead of an infinite number of particulars, a few may be selected, that shall more advantageously answer the same end: for the like is to be done in enquiries. So that the design here seems to have been to indicate a few capital, or leading enquiries, which being duly prosecuted, should unfold nature as effectually as if all possible enquiries were prosecuted, thus proportioning the business of perfecting philosophy to the shortness and casualties of life. What these enquiries are, may be learnt from those which the author directly went upon, and those he intended to have proceeded with†, and in what order these enquiries should be prosecuted, or which should come first, which second, &c. must be determined

* See Mr. Boyle's Method of Prosecuting Enquiries, Abridg. Vol. I. in init. p. 24, 25.

† See Dr. Hook's Method of Improving Philosophy, p. 18—70.

either according to their utility in life, or the tendency they have to prepare the way, and lead to, or facilitate the rest, and perfect the entire body of philosophy*.

(5.) The Limit of Enquiry, or an inventory of all the natures in the universe, is the head that comes next in order; under which, in all probability, the author intended to shew, that the whole scheme of his work was no impossible or infinite thing, but limited and circumscribed within moderate bounds, so as to be executed by men in their present state, without a miracle, by the due exercise of their faculties for a competent time: since nature herself is limited, and since the universe consists but of a certain number of simple natures combined into numerous things, as the letters of the alphabet are into numerous words: whence if these simple natures were understood, the whole system of things might be easily unravelled.

The principal difficulty seems to lie in the collecting a just and sufficient history of nature and art; for if this was once procured, the rest would follow almost spontaneously. And yet this his-

* The direction of the Medicina Mentis is here different as it would have no regard paid to excellence or utility, and nothing to be primarily intended but the simple discovery of truths See that Work, p. 209—212.

tory, when soberly and prudently considered, will be found no monstrous or impracticable undertaking, provided the proper expence be allowed, a suitable number of hands be employed, and the true method of doing it be observed*. The author has endeavoured to give an epitome of the whole thing, in the compass of a few lines.

(6.) The next general head is the Reducing of Enquiries to Practice, or making them subservient to human uses. This seems chiefly to regard the conducting of enquiries, where not forms, axioms, or canons, are the things in view, nor even the discovery of experiments; but where works and new arts are to be invented, laid out, and brought into use, for a common benefit and advantage. And the general method of effecting this was above observed to be by proceeding downwards, from general axioms, to the particular work proposed.

---

* See Dr. Hook's Method of improving Natural Philosophy, p. 27, 29, 36; but particularly p. 21, where the Doctor has these words: "I have very good reason to believe that the whole mass of Natural History may be "contained in much fewer words than the writings of divers "single authors; and the method of using them will be "much more easy, and the labour of interpreting or understanding them, if done aright, will be almost as easy, as "to unravel a bottom when you begin at the right end."

But besides this, the author intended to shew the method of making general practical tables, for laying out works with the greater ease, and bringing them more speedily to perfection. And in this view it seems to be, that in every enquiry he constantly reserved a particular head, or table, for receiving the things that more immediately regarded practice, and human uses.

Again, besides the method of deriving new arts, or works, from axioms, there is another more mechanical and facile method of deriving them from former experiments, or works themselves, which method, though by no means so safe and certain as the former, may however prove of considerable service, especially if it were duly cultivated and improved.

(7.) The next head is Preliminaries to Enquiry; by which it may be conjectured the author meant not only the getting rid of prejudices and false notions; the consulting one's own genius, disposition, and abilities; but likewise the procuring all necessary assistances for the purpose; and particularly using the artificial armour, or machinery of the mind, so that the mind may act in the highest degree of its powers and faculties *. And under this preparation may be in-

* See Dr. Hook's Method of improving Philosophy, p. 12, 18, 42, 64.

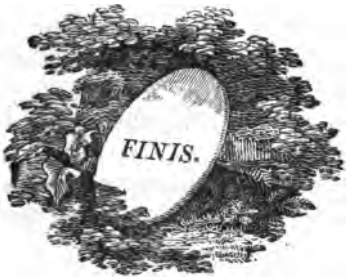
cluded tables or heads of enquiry, previously drawn up, to direct the mind what particulars it should enquire after; what queries it should make; and what intimations it should observe, with regard to the subsequent business of interpretation *, &c.

(8.) The last general head of the second part of the Novum Organum, is the Ascending and Descending Scale of Axioms; which was touched above. It may be farther added, that the business of enquiry, and the improvement of universal philosophy, depend entirely upon (1.) forming axioms from particulars by legitimate induction; (2.) verifying these axioms; (3.) raising still nobler and more general axioms from the former, till those of the highest order are obtained, reaching even to the universalities of nature; and (4.) resolving these sublime axioms again, by sure steps or gradations, into lower axioms, that lead to an unlimited practice, and discover all the arts and works that are wanting to accommodate human life.

And thus the general heads that require to be filled up, for perfecting the design of the Novum Organum, have been briefly spoke to, either in the way of conjecture, or from parallel places

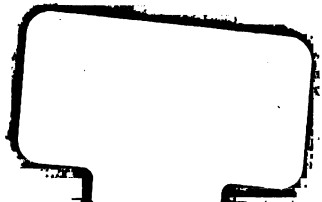
* See Dr. Hook's Method of improving Philosophy.

of the author; with this view, that persons of leisure, who have been versed in practical, as well as speculative philosophy, may be the readier induced to finish a work whereon the good of mankind so much depends.



J. CUNDEE, PRINTER,
Ivy-lane.

THE NEW YORK PUBLIC LIBRARY
REFERENCE DEPARTMENT

This book is under no circumstances to be taken from the Building

Form 419